GL00552-01

Invasive Non-native Plant Management During 2000

by

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Administrative Report 01-07
July 11, 2001

Great Lakes Indian Fish
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INTRODUCTION

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an organization exercising delegated authority from 11 federally recognized tribes in Minnesota, Wisconsin, and Michigan (Figure 1). These tribes retain hunting, fishing, and gathering rights in the territories ceded to the United States through various treaties (Figure 1). The exercise of these rights may be threatened by the degradation of native ecosystems by invasive non-native plants.

This report summarizes the activities undertaken by GLIFWC staff during 2000 to address the spread of invasive non-native plant species in the ceded territories. GLIFWC staff have conducted annual inventory and control work on purple loosestrife (*Lythrum salicaria*) since 1988 (Gilbert and Parisien 1989, Edblom et al. 1995, Gilbert et al. 1995, Gilbert et al. 1998, Falck et al. 1999, Falck et al. 2000). In 2000, GLIFWC staff identified the need to 1) reassess the distribution of purple loosestrife within the Bad River-Chequamegon Bay watershed to evaluate past control efforts, 2) continue and expand control activities via an ambitious biological control program, 3) continue educational outreach activities aimed at preventing the introduction and spread of additional exotic plants, and 4) continue to coordinate activities with other resource agencies, universities, non-governmental organizations, and the general public.

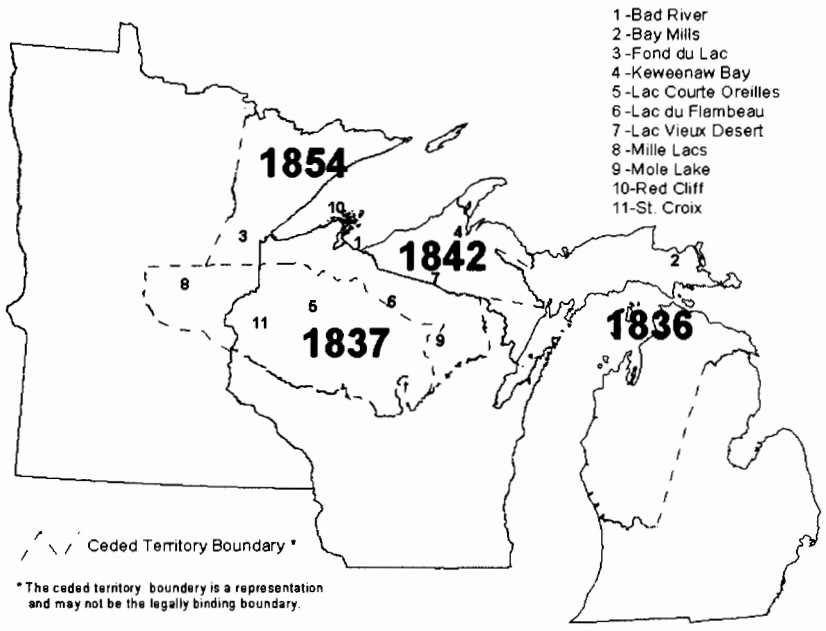

Figure 1. Location of GLIFWC member tribes and ceded territories.

EVALUATION OF PAST PURPLE LOOSESTRIFE CONTROL EFFORTS WITHIN THE BAD RIVER WATERSHED

The primary objectives of the 2000 survey for purple loosestrife within the Bad River - Chequamegon Bay watershed were to evaluate the effectiveness of past control efforts and to gather data to guide future control efforts.

METHODS

Methods were based on similar surveys conducted in 1994 (Edblom et al. 1995) and 1995 (Gilbert et al. 1995) to allow valid comparisons of data. Field surveys were conducted during July, August, and September 2000 following the same routes used in 1994 and 1995 (Figure 2). Observations were made from a truck or boat traveling slow enough to identify flowering loosestrife plants. In stands < 10m in length along their longest axis, all loosestrife plants were counted and categorized by class (Thompson et al. 1987). For stands ≥ 10m in length, a transect running parallel to the stand's longest axis consisting of 10 evenly spaced $1m^2$ plots was used to measure density. Areal extent was estimated using a quadrat frame and pacing as a reference where appropriate. Locations were recorded using a hand-held GPS receiver. Additional site attributes were recorded to facilitate correlation of purple loosestrife occurrence with various site attributes to improve the efficiency of future inventory and control efforts (Table 1). All data were compiled into a GIS database for analysis.

RESULTS

A total of 97 discrete populations of purple loosestrife were found along the survey routes in 2000 compared to 217 populations in 1994-95 (Figure 3). Total area decreased by slightly more than 370 acres (Table 2, Figure 4). In contrast, total density increased by 323 plants/m^2 (Table 2, Figure 5).

DISCUSSION

Purple loosestrife control efforts within the Bad River-Chequamegon Bay watershed have been jointly implemented by GLIFWC, Bad River Natural Resources Department (BRND) and The Nature Conservancy (TNC). Control efforts have focused on Fish Creek Sloughs (GLIFWC), highway 13 rights-of-way between Ashland and Highbridge (GLIFWC), private lands in the Highbridge area (TNC, GLIFWC), and the Kakagon Sloughs (BRND).

Substantial reductions in areal extant were observed in the Highbridge area, the Kakagon Sloughs, and the highway 13 right-of-way between Ashland and Highbridge where past control efforts have been focused. Although these same areas showed increases in the number of discrete populations, this may be the result of the previously larger populations being fragmented

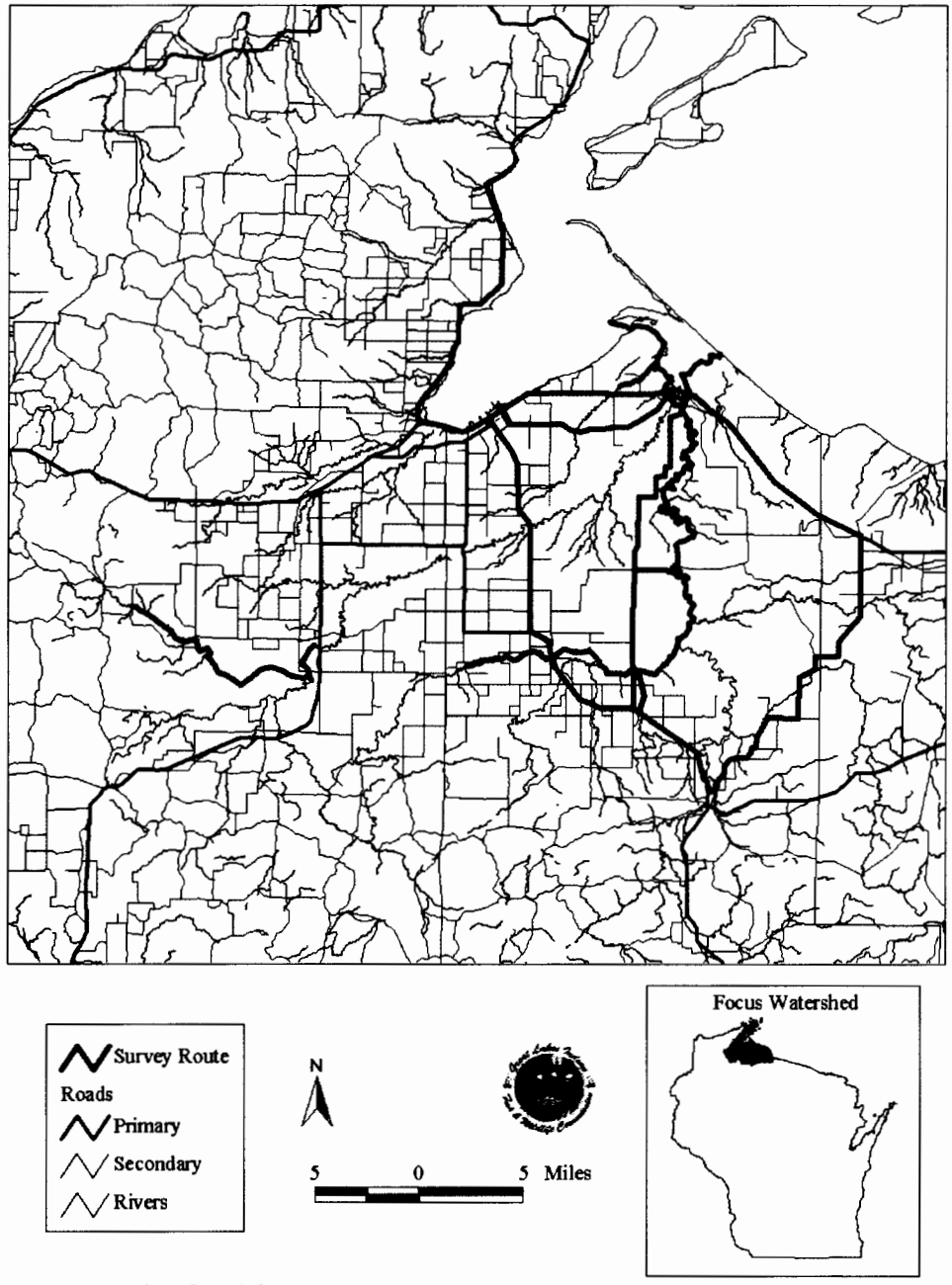

Figure 2. Location of purple loosestrife survey route.

Table 1. Additional site attributes collected during 2000 Bad River - Chequamegon Bay watershed purple loosestrife survey.

Attribute	Categories
Habitat	open
	wooded
	shoreline
	woodland edge
Hydrology	wet
	dry
	seasonally wet
Land Use	natural area
	agricultural
	urban
Disturbance	unknown
	none
	travel corridor
	cultivation
	logging
	mowing
	construction
Land Ownership	private
	county
	federal
	tribal

into numerous smaller populations from control activities. This hypothesis is supported by the fact that the mean area of each loosestrife population has decreased substantially between 1995 and 2000 ($_{94\text{-}95}$ = 6966.4 m^2 vs. $_{2000}$ = 67.9 m^2) . Similarly, total density within the survey area increased dramatically, however, Class I plants were responsible for the greatest increase in plant density. Class I plants are small pioneering plants that typically emerge from the residual seed bank following control measures that release young seedlings from competition. This was corroborated by a substantial decrease in the density of Class II plants and only a slight increase in the density of Class III plants whose mature flowering spikes were the primary targets of chemical control crews searching for areas to treat.

Reductions in areal extant along highway 13 between Ashland and Washburn probably reflect the impacts of recent highway construction activities. During the summer of 2000, a passing lane was added to this stretch of highway and the adjacent loosestrife-infested right-of-way was entirely excavated. Increases in loosestrife areal extant were detected at Beartrap Creek on the

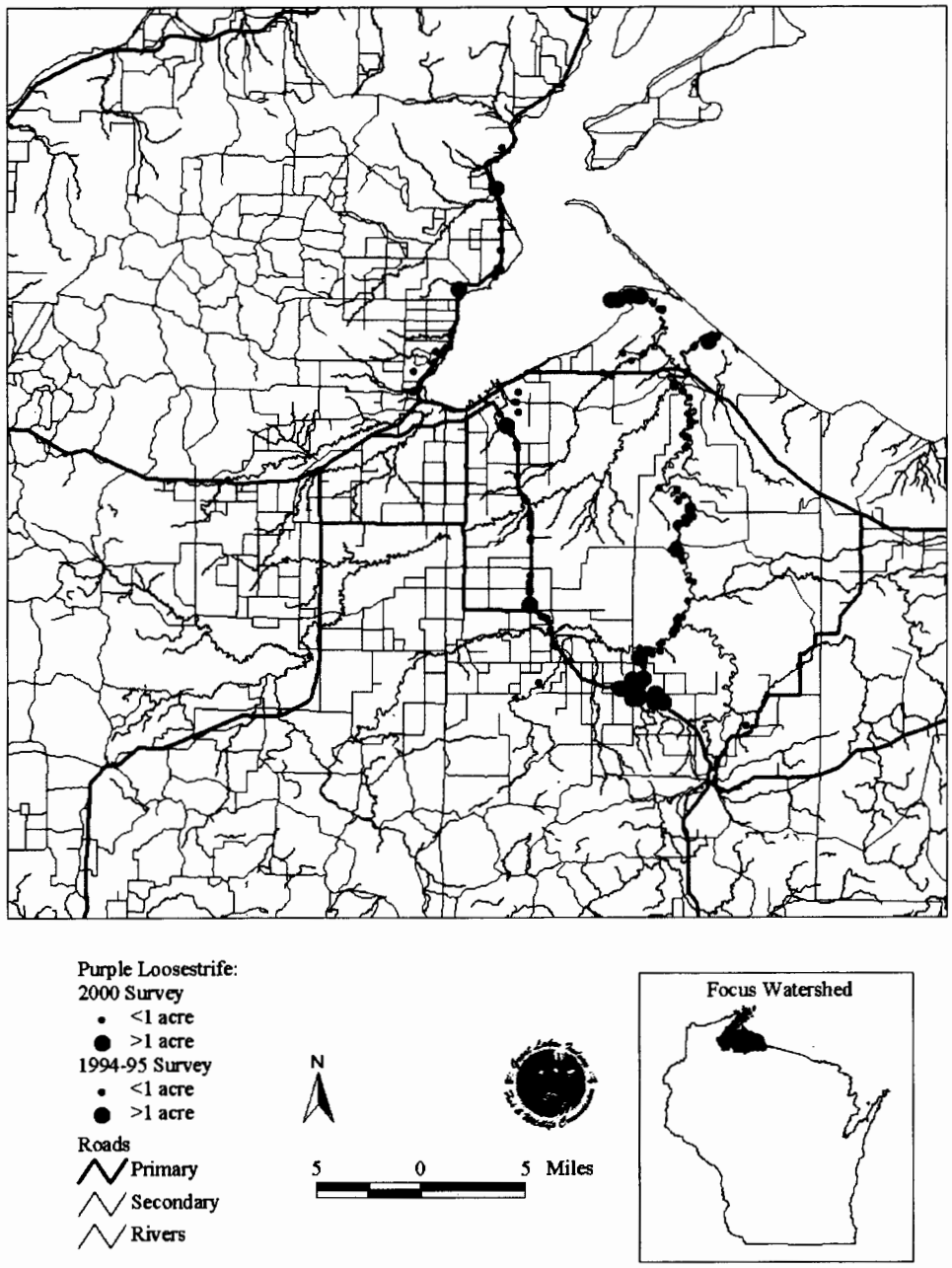

Figure 3. Location and areal extant of purple loosestrife, 1994-95 vs. 2000.

Bad River Indian Reservation and the Sioux River Sloughs near Washburn where no active control measures have occurred in the past. *Galerucella* beetles, a biological control, were released at the Sioux River Sloughs in 2000 and the Bad River Tribe is currently weighing control options for the Beartrap Creek site. The Bad River corridor was treated for the first time in 2000 after the survey was conducted. Changes in loosestrife abundance detected along the Bad River probably resulted from natural erosion along the river's banks.

Overall, it appeared that chemical control efforts have been used successfully to reduce the abundance and areal extant of purple loosestrife where these measures have been employed on a consistent annual basis. The increase in the density of Class I plants at these sites illustrates the point that chemical control is a long term commitment and the decision to use this method requires careful consideration of this fact prior to implementation. GLIFWC proposes to continue the use of chemical control on small sites that are the easiest to eradicate and to use biological controls where large populations would dictate a substantial annual commitment to treat with herbicides.

Table 2. Change in number of populations and density from 1994-2000 for purple loosestrife in the Bad River - Chequamegon Bay watershed.

Location	No. Populations	Area (acres)	Density (plants/m^2)			
			Class I[a]	Class II[b]	Class III[c]	Total
Highway 13 North	-58	-10.4	37.6	-271.0	-60.6	-267.8
Highway 13 South	0	-11.2	160.7	10.5	19.7	190.6
Bad River	-29	-0.7	61.2	7.5	32.7	101.4
Beartrap Creek	-4	0.5	33.6	-22.7	-1.0	7.3
County Rd. A	0	-0.2	121.1	-7.1	-1.4	125.6
Highbridge	-5	-144.5	-0.4	0.9	7.6	9.2
Honest John	-2	-2.6	1.0	-0.2	6.4	7.2
Kakagon Sloughs	-6	-110.4	27.0	3.6	0.3	14.9
Marengo River	-13	0.0	25.0	-2.0	1.0	24.0
Silver Creek	-2	-92.3	52.3	9.1	35.0	136.4
Highway 169	0	0.0	-17.0	-5.0	-3.0	-25.0
Highway 2	-1	0.0	0.0	-0.2	0.0	-0.2
Totals	-120	-371.8	+502.1	-276.6	+36.7	+323.6

a Small scattered plants with 1-5 flowering stems/rootstock.
b Mature plants with ≥ 10 flowering stems/rootstock, clumps sometimes forming aggregate floral masses.
c Aggregates closing to form large monospecific patches or stands.

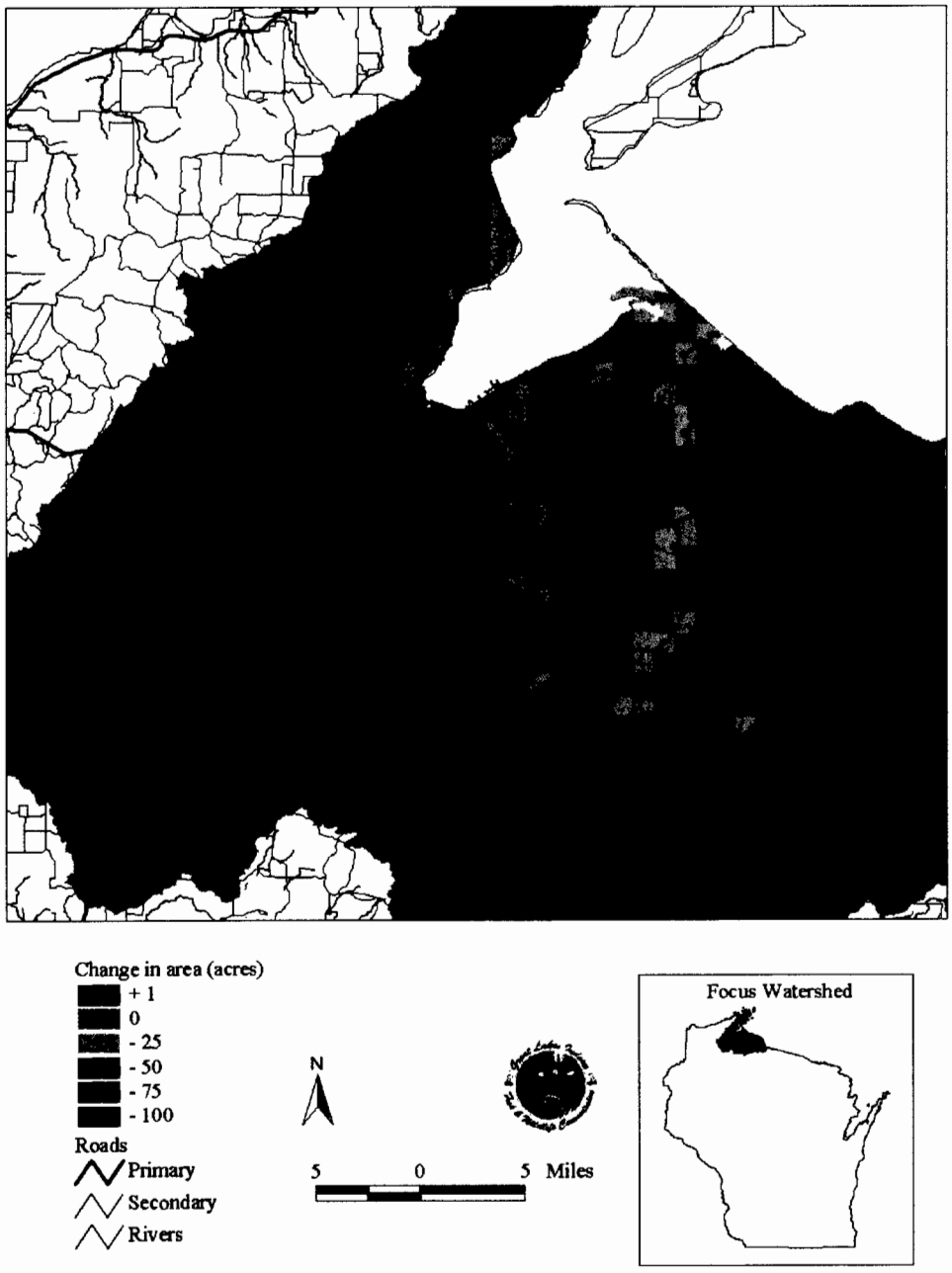

Figure 4. Change in areal extant of purple loosestrife by section, 1994-2000.

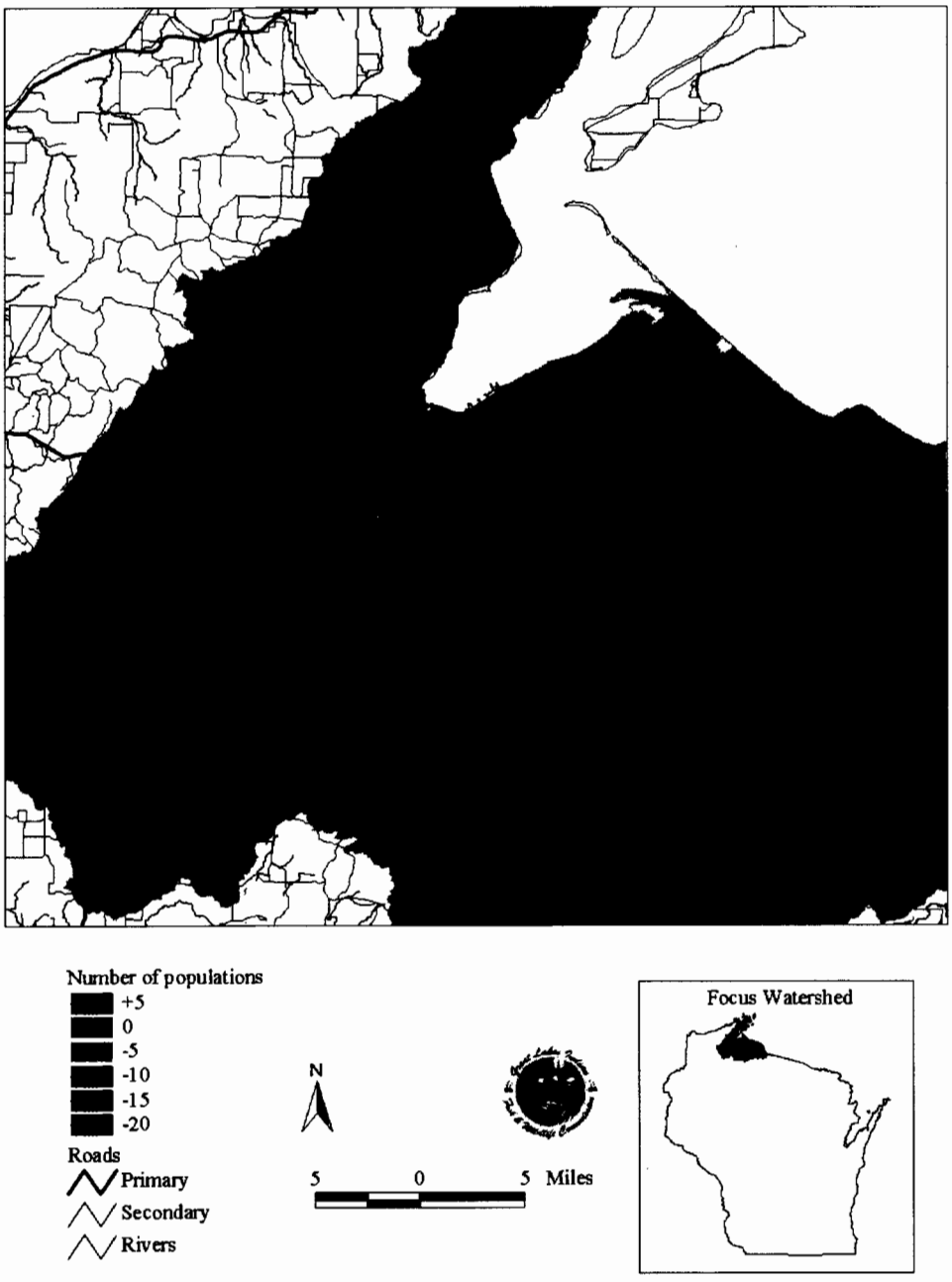

Figure 5. Change in number of purple loosestrife populations by section, 1994-2000.

CONTROL ACTIVITIES IN THE BAD RIVER-CHEQUAMEGON BAY WATERSHED

METHODS

Purple loosestrife populations within the Bad River - Chequamegon Bay watershed were inventoried in 1994, 1995, 1999, and 2000 (Gilbert et al. 1995, Edblom et al. 1995, Falck et al. 2000). Data from these surveys were used to prioritize effort and select control methods based on the area of the site, number of plants, and the site's location within the watershed. Small sites with few plants that threatened to infest downstream reaches were given the highest priority for chemical control (Figure 6). Large sites ($\geq$ 1 acre or $\geq$1,000 plants) were given low priority for chemical control but high priority for biological control (Figure 6).

Chemical Control:

Prior to conducting field applications of herbicide, all loosestrife control workers attended a 1 day training workshop conducted by GLIFWC staff. Participants learned or reviewed safe handling, storage, and application procedures, applicable state and federal regulations, and received training on equipment operation and maintenance.

Herbicides were applied to loosestrife stands using back pack sprayers. Glyphosate, a non-selective herbicide, was used in very dense stands or over-water. The dicot-specific herbicide triclopyr was used on dry sites including road-side ditches and fields. Efforts were focused primarily on Fish Creek Sloughs, and the highway 13 right-of-way between Highbridge and Washburn. Private uplands in the Highbridge area were treated primarily by staff from TNC with assistance from the GLIFWC crew after consent forms were signed by the landowner.

Biological Control:

In 2000, GLIFWC initiated a biological control program, rearing approximately 70,000 *Galerucella* beetles for distribution within the watershed. The release of *Galerucella* beetles (native to Europe) in the United States for biological control of purple loosestrife was approved by USDA - APHIS in 1992. The beetles were reared following methods outlined by Loos and Ragsdale (1998). Mature purple loosestrife root stock was transplanted into pots from a population on WI DNR property at the mouth of the Sioux River. The UW-Extension's Ashland Agricultural Research Station provided space for rearing the *Galerucella* beetles. Ninety potted plants were placed in small wading pools filled with 4-6 inches of water. In late May and early June, adult *Galerucella* beetles were collected from previous release sites and placed on the potted plants. Approximately 10 beetles were placed on each plant and a mesh net bag was placed over each plant to protect the beetles and larvae from bird and insect predation (Figure 7). An estimated 750 adult beetles were reared in each pot.

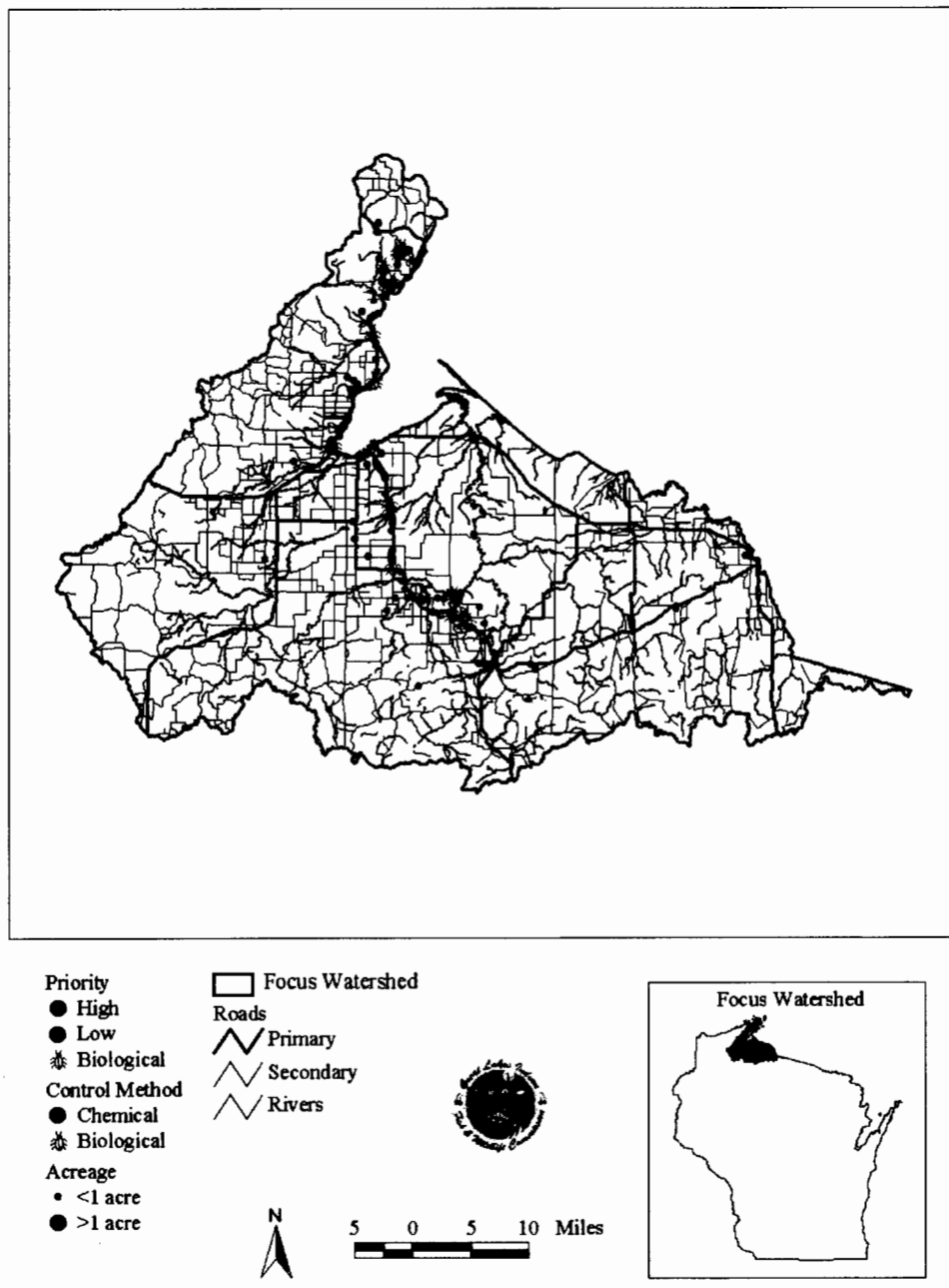

Figure 6. Control priority and method for off-reservation purple loosestrife sites, 2000.

Figure 7. Rearing *Galerucella* beetles.

Evaluation

Spatial data collected during annual surveys were used to quantify the progress of control efforts. Treated loosestrife patches were identified on maps and coded for control in 2000. Each *Galerucella* release site was photographed during the peak of purple loosestrife's blooming period to document the pre-treatment condition of each site. Summary statistics of treated patches were determined with ArcView GIS.

RESULTS

A total of 88 sites comprising 46 acres of purple loosestrife were treated in 2000. Biological control was used on 14 sites comprising 6 acres, and chemical controls were applied to 74 sites comprising 40 acres (Figure 8). A partnership between the Natural Resources Conservation Service (NRCS), The Nature Conservancy (TNC), and GLIFWC helped provide funding for control work on private lands within the watershed. GLIFWC crews treated 35 sites comprising 6 acres and TNC crews treated 53 sites comprising 40 acres (Figure 8).

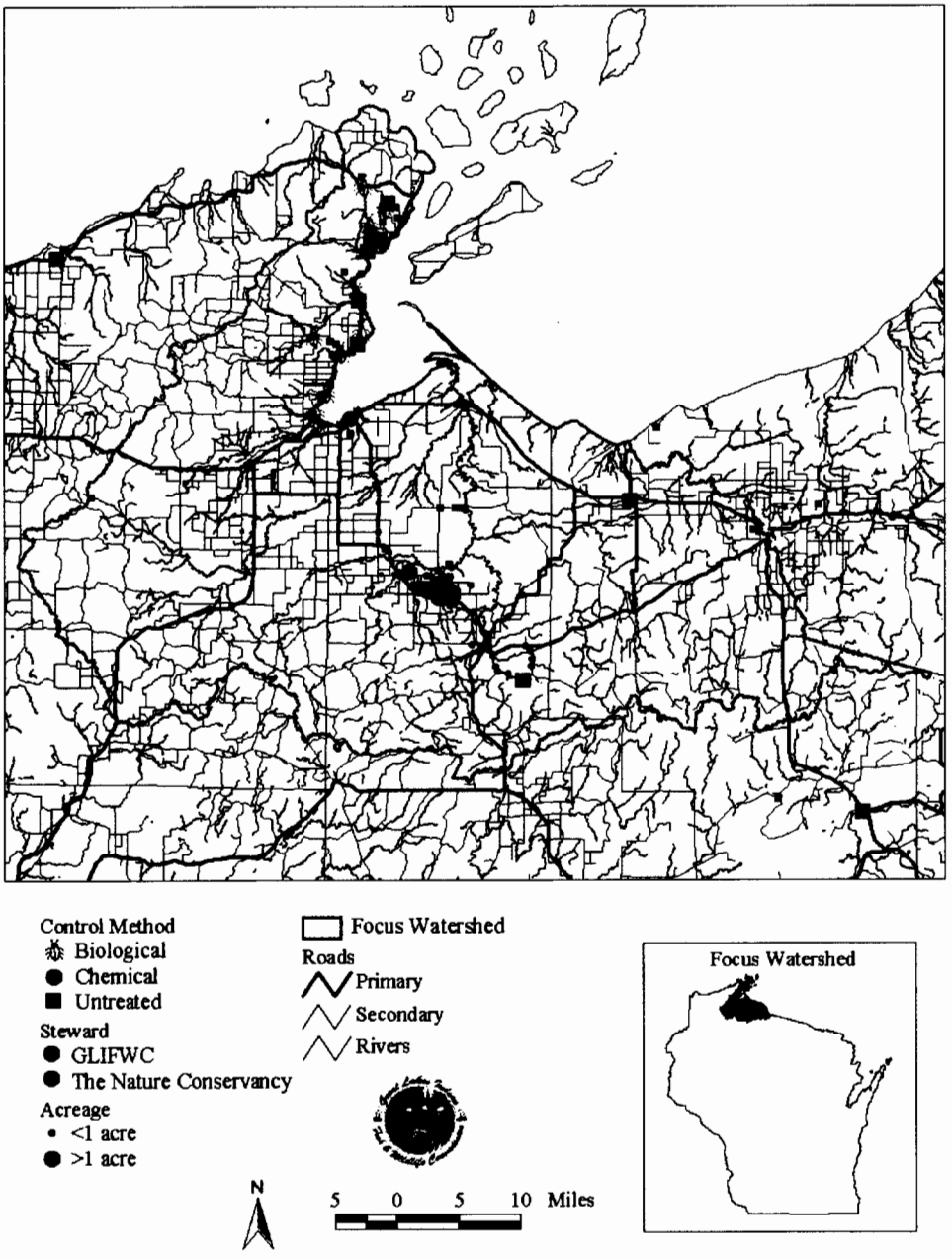

Figure 8. Purple loosestrife control activity in the Bad River - Chequamegon Bay watershed, 2000.

The addition of biological control as a management tool has allowed GLIFWC to expand the scope of its control efforts significantly because the application of biological controls requires far less time than chemical control methods. In addition, one-time applications of biological controls are far more palatable to private landowners who have concerns about annual treatments with herbicides. The result has been significantly increased cooperation from private landowners.

FUTURE WORK

In 2001, GLIFWC plans on expanding its biological control efforts and continuing to use chemical controls on small isolated populations that can be easily eradicated. All biological control sites will be monitored closely for overwinter survival and relative loosestrife density to evaluate the effectiveness of this treatment method.

EXOTIC PLANT EDUCATION AND OUTREACH ACTIVITIES

BACKGROUND

Human activities are responsible for the vast majority of new introductions of invasive non-native plants. Unfortunately, the general public is largely unaware of the negative ecological impacts caused by invasive weeds and the role humans play in their spread. Consequently, numerous invasive plants continue to be dispersed across the landscape by people enjoying outdoor activities. Therefore, effective weed prevention and control is dependent upon the cooperation and assistance of an informed public. To address this problem, GLIFWC implemented an educational outreach program in 1998 that provided current and relevant information to inform the general public of this important issue and the steps to take to minimize the spread of exotic plants.

PROGRAM OVERVIEW

A suite of educational materials was utilized during 2000 to reach a broad range of audiences. This material included brochures, slide presentations, and a comprehensive website that highlighted several exotic plant species of concern in the upper Great Lakes region. GLIFWC distributed brochures and slide shows to the public primarily via cooperating state, federal, county, and tribal resource management agencies throughout the upper Great Lakes region. Other audiences were reached through our website (www.glifwc.org/epicenter/) which has received over 1,900 visits since July 2000. In addition, several presentations were conducted over the summer in conjunction with local environmental events.

ACCOMPLISHMENTS

Brochures

Over 2,400 purple loosestrife brochures were distributed to cooperating resource management agencies, non-government organizations, and private citizens (Table 3). A new brochure/poster titled *Plants Out Of Place* was completed with the editorial and financial assistance of several county, state, and federal agencies, non-government organizations, and private companies (Table 4). The poster provides general information on the ecological, social, and economic impacts of invasive non-native plants in general and how they spread across the landscape. The reverse side highlights several invasive plants of concern in the upper Great Lakes and provides suggestions for slowing their spread and contact information for more information. *Plants Out Of Place* received a warm welcome from resource professionals working to spread the word about exotic plants and over 46,000 were distributed in 2000 (Table 4).

Table 3. Summary of purple loosestrife brochure distribution, 2000.

Organization	No. Brochures
Apostle Islands National Lakeshore	100
TNC- Ashland	100
TNC - MI	150
Michigan Technological University	200
Polk County Land & Water Dept.	200
Hiawatha National Forest	250
WI DNR - Superior	300
Adopt-A-Lake, UWSP	550
UW Extension	600
Total	2,450

Outreach

Over 500 people attended presentations by GLIFWC staff at local events (Table 5). Most of the presentations consisted of the slide show *What You Should Know About Purple Loosestrife* followed by a 15 minute discussion period. A purple loosestrife display was also set up at many of the engagements and brochures were made available for participants to take with them.

REMAINING NEEDS

In addition to purple loosestrife, there are scores of additional exotic plants present throughout the upper Great Lakes region. However, they vary in their impact to natural ecosystems and feasibility of control. GLIFWC staff are currently evaluating these species to determine which ones pose the greatest threats to local ecosystems and have the greatest likelihood for successful control. Preliminary results suggest that spotted knapweed, leafy spurge, garlic mustard, bush honeysuckles, and buckthorn will rank in the top ten for species which merit additional management activities.

A need for additional educational materials is anticipated for those species that rank high in the evaluation and for which suitable educational materials are presently unavailable. The development of additional educational materials will begin in 2002 and will follow the same process used for purple loosestrife:

1) searching for and acquiring existing educational materials if available
2) identifying gaps in existing educational efforts
3) identifying the most appropriate audience to target
4) selecting appropriate media formats
5) translating scientific documents into language suitable for a general audience, and
6) presenting the information in an organized and visually appealing format

Table 4. Partners and distributors of brochure/poster *Plants Out Of Place*, 2000.

Organization / Agency	Partner/Distributor	# Brochures
USFWS	Distributor	50
Sigurd Olsen Environmental Institute	Distributor	50
Adopt-A-Lake, UWSP	Distributor	100
St. Croix Band	Distributor	100
Bad River Band	Distributor	100
Bay Mills Indian Community	Distributor	100
Cable Natural History Museum	Distributor	100
Sokaogon Chippewa Community	Distributor	100
Fond du Lac Reservation	Distributor	100
Lac Courte Oreilles Band	Distributor	100
Red Cliff Band	Distributor	100
Northern Forest Restoration Workshop	Distributor	100
Keweenaw Bay Indian Community	Distributor	100
Lac Vieux Desert Band	Distributor	100
Lac du Flambeau Band	Distributor	100
Mille Lacs Band	Distributor	100
Apostle Islands National Lakeshore	Distributor	200
Michigan Technological University	Distributor	200
Northern Great Lakes Visitor Center	Distributor	300
UW Extension	Distributor	500
Polk County Land & Water Dept.	Distributor	500
ACE High School	Partner	600
Vilas Co. Land, Air & Water Conserv. Dept.	Partner	600
GLIFWC	Partner	900
Applied Ecological Services	Partner	1,000
Wis. Electric & Power Co.	Partner	1,000
Mich. Assoc. of Conserv. Dists.	Partner	1,000
NRCS	Partner	1,020
The Nature Conservancy	Partner	2,250
MN DNR	Partner	3,000
Chequamegon-Nicolet National Forest	Partner	3,000
Huron-Manistee National Forest	Partner	3,000
PRI-RU-TA RC, & D	Partner	3,000
Ottawa National Forest	Partner	3,000
Hiawatha National Forest	Partner	3,000
WI DOT	Partner	3,000
MI DEQ	Partner	4,000
WI DNR	Partner	4,900
MI DNR	Partner	5,000
Total		46,470

Table 5. Summary of educational outreach engagements , 2000.

Event / Location	Location	Sponsor	Date	Attendance
Home & Garden Show	Ashland Civic Center	GLIFWC	04/01/00	> 100
Environmental Extravaganza	Ashland High School	Northland College	04/08/00	> 50
Earth Day	Northern Great Lakes Visitor Center	GLIFWC	04/21/00	> 100
Celebrating Wildlfowers Day	Northern Great Lakes Visitor Center	GLIFWC	05/27/00	> 50
Biological Control Workshop	Ashland Agricultural Research Station	GLIFWC	06/03/00	2
Landscaping With Wildflowers	Northern Great Lakes Visitor Center	GLIFWC	07/08/00	12
Ashland County Fair	Ashland County Fair Grounds	Ashland County 4-H	07/13/00	> 100
Bayfield County Fair	Bayfield County Fair Grounds	Bayfield County 4-H	08/10/00	> 100
Total				> 514

COORDINATION WITH OTHER AGENCIES AND ORGANIZATIONS

An ad hoc forum called the "Northwoods Weed Initiative" (NWI) has met regularly to share information, coordinate activities, and discuss future collaborations to address invasive non-native plants in northern Wisconsin and Michigan. Participants include GLIFWC, Lac Courte Oreilles Band of Lake Superior Ojibwa, the Chequamegon-Nicolet National Forest, the Ottawa National Forest, The Nature Conservancy, PRI-RU-TA RC & D, the Natural Resources Conservation Service, and the WI DNR. The Northwoods Weed Initiative recognizes the inherent problems (i.e. labor intensive, cross jurisdictional boundaries, etc.) associated with managing invasive exotic plants and strives to address these obstacles by working together in a coordinated manner (see Appendix A).

In 2000, NWI was instrumental in completing the *Plants Out Of Place* poster/brochure described above. In addition, NWI helped organize a regional conference on invasive non-native plants in Eau Claire, WI. GLIFWC staff were responsible for administering the conference web site. Plans are currently being developed to revise several agency technical guidelines that provide guidance for re-vegetation and erosion control activities. NWI participants plan to review these documents to insure that the use on non-native plants are not encouraged and suggest revisions where appropriate.

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Appendix A

Northwoods Weed Initiative

An interagency forum to protect the integrity of native ecosystems in northern Wisconsin and Michigan

Participants:

Chequamegon - Nicolet National Forest
Great Lakes Indian Fish & Wildlife Commission
Lac Courte Oreilles Band of Lake Superior Ojibwe
Leech Lake Band of Ojibwe
Natural Resources Conservation Service
Ottawa National Forest
PRI-RU-TA RC & D
The Nature Conservancy
Wisconsin DNR

Invasive non-native plants can have devastating impacts on native plant communities, fish and wildlife habitat, agricultural yields, recreational and subsistence opportunities, and ultimately, local economies. Purple loosestrife, reed canary grass, spotted knapweed, Canada thistle, Eurasian water milfoil, and common buckthorn are examples of invasive non-native plants that negatively impact local natural areas and agricultural lands.

Because these plants disperse widely across the landscape and administrative boundaries, it is advantageous to work cooperatively towards management and control objectives. In addition, the number of new exotics being introduced into local ecosystems continues to out-pace control activities, and is too much for any one agency to manage alone.

The present status of the Northwoods Weed Initiative is an informal consultative body with formal partnerships developed on a project specific basis. The Northwoods Weed Initiative provides a forum to share information and collaborate on planning initiatives for exotic plant issues in northern Wisconsin and Michigan. Initial plans for the Northwoods Weed Initiative include 1) planning a regional conference that will present information on local exotic plant issues, provide a forum for sharing information, and identify common objectives and 2) development and distribution of an informational poster to raise public awareness of this important issue.

For more information, please contact:

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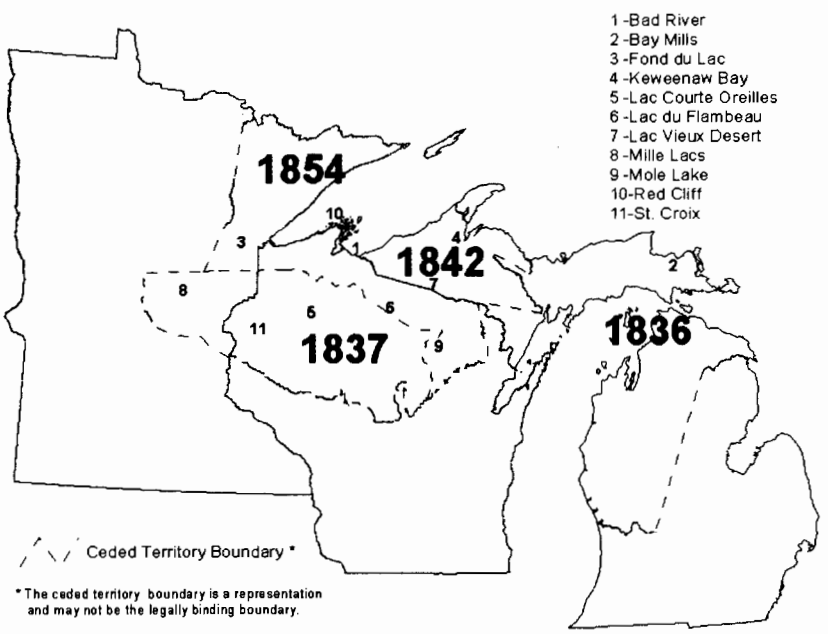

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DISCUSSION

Purple loosestrife control efforts within the Bad River-Chequamegon Bay watershed have been jointly implemented by GLIFWC, Bad River Natural Resources Department (BRND) and The Nature Conservancy (TNC). Control efforts have focused on Fish Creek Sloughs (GLIFWC), highway 13 rights-of-way between Ashland and Highbridge (GLIFWC), private lands in the Highbridge area (TNC, GLIFWC), and the Kakagon Sloughs (BRND).

Substantial reductions in areal extant were observed in the Highbridge area, the Kakagon Sloughs, and the highway 13 right-of-way between Ashland and Highbridge where past control efforts have been focused. Although these same areas showed increases in the number of discrete populations, this may be the result of the previously larger populations being fragmented

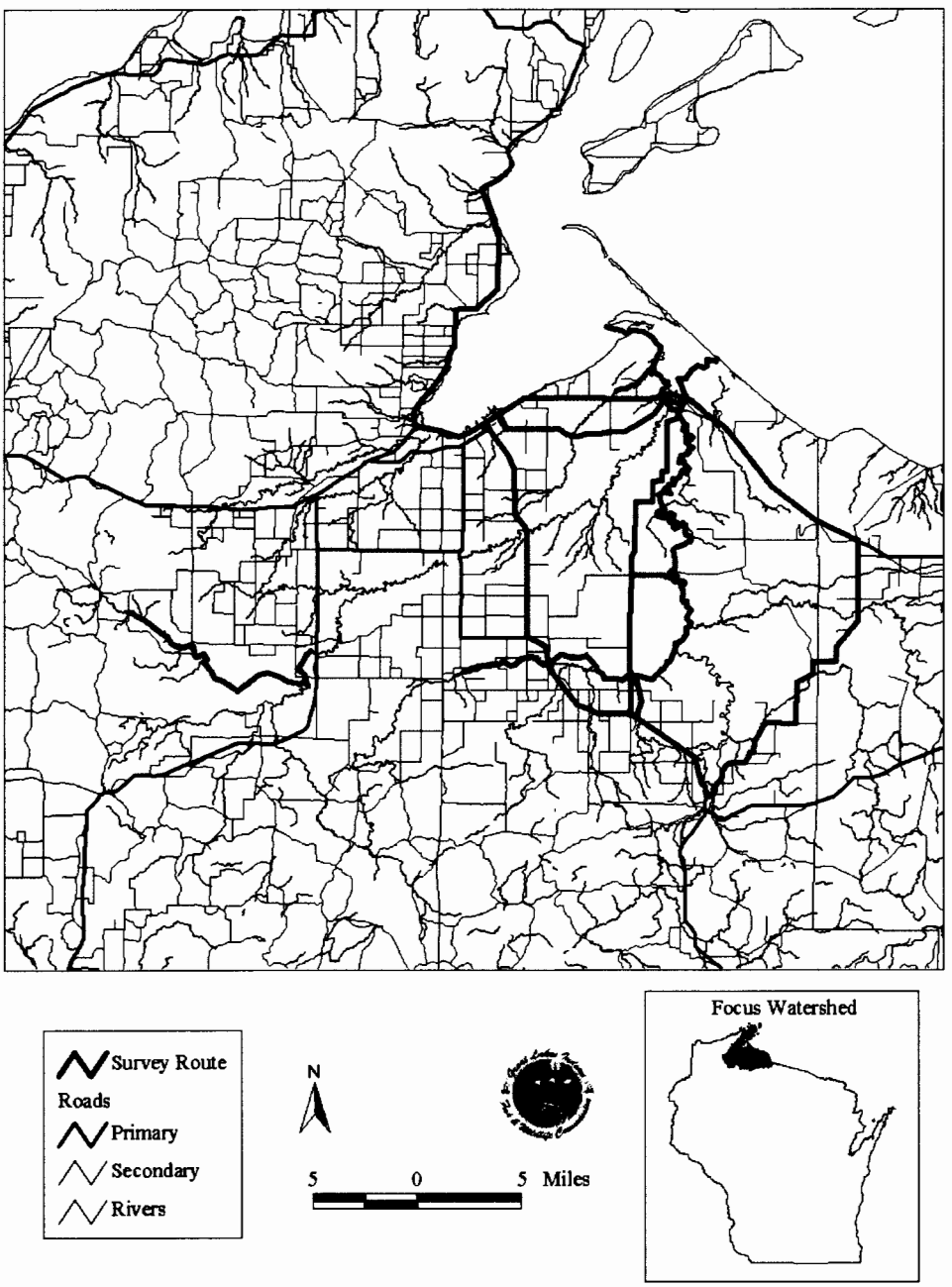

Figure 2. Location of purple loosestrife survey route.

Table 1. Additional site attributes collected during 2000 Bad River - Chequamegon Bay watershed purple loosestrife survey.

Attribute	Categories
Habitat	open wooded shoreline woodland edge
Hydrology	wet dry seasonally wet
Land Use	natural area agricultural urban
Disturbance	unknown none travel corridor cultivation logging mowing construction
Land Ownership	private county federal tribal

into numerous smaller populations from control activities. This hypothesis is supported by the fact that the mean area of each loosestrife population has decreased substantially between 1995 and 2000 ($_{94\text{-}95}$ = 6966.4 m^2 vs. $_{2000}$ = 67.9 m^2) . Similarly, total density within the survey area increased dramatically, however, Class I plants were responsible for the greatest increase in plant density. Class I plants are small pioneering plants that typically emerge from the residual seed bank following control measures that release young seedlings from competition. This was corroborated by a substantial decrease in the density of Class II plants and only a slight increase in the density of Class III plants whose mature flowering spikes were the primary targets of chemical control crews searching for areas to treat.

Reductions in areal extant along highway 13 between Ashland and Washburn probably reflect the impacts of recent highway construction activities. During the summer of 2000, a passing lane was added to this stretch of highway and the adjacent loosestrife-infested right-of-way was entirely excavated. Increases in loosestrife areal extant were detected at Beartrap Creek on the

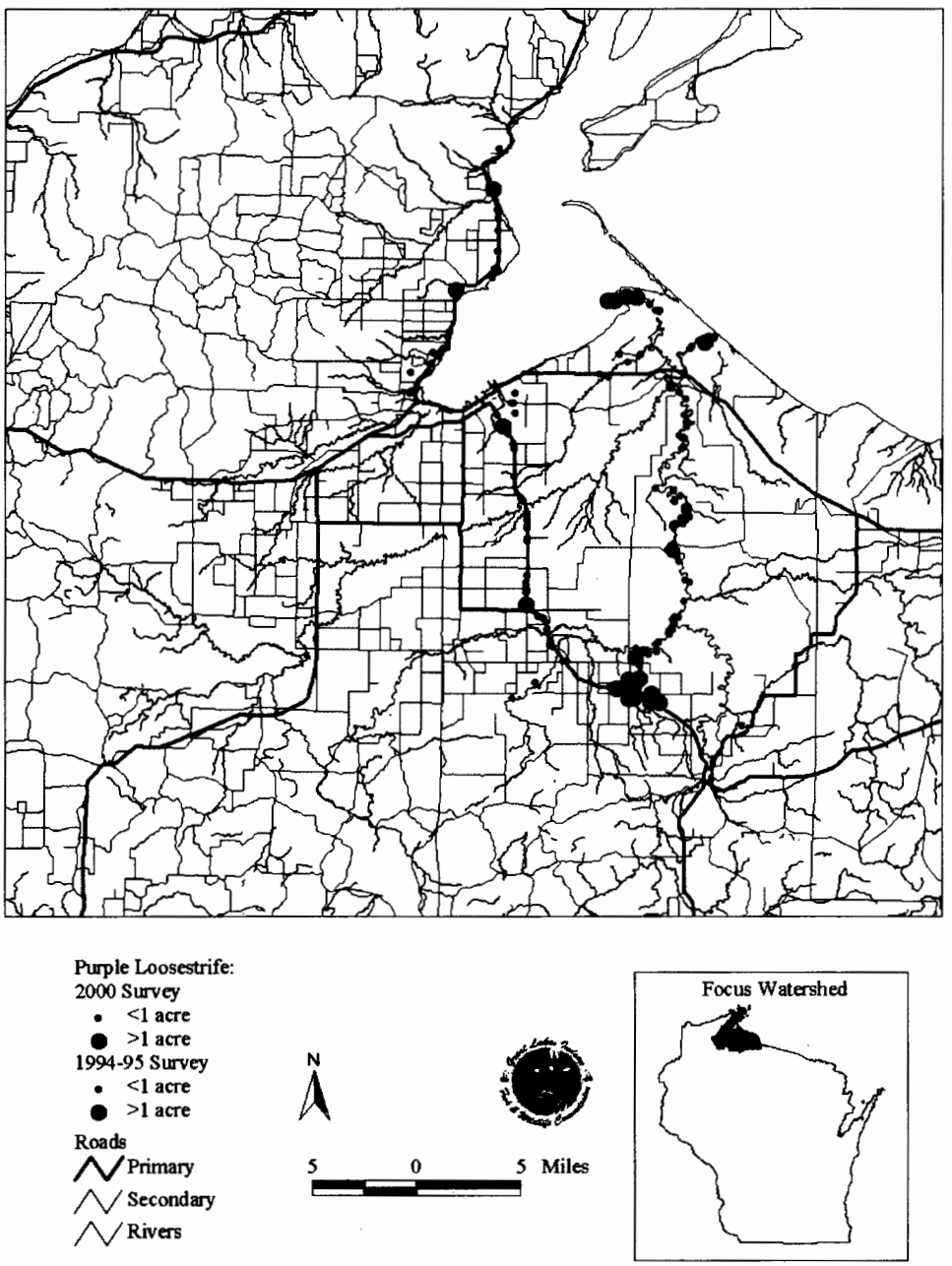

Figure 3. Location and areal extant of purple loosestrife, 1994-95 vs. 2000.

Bad River Indian Reservation and the Sioux River Sloughs near Washburn where no active control measures have occurred in the past. *Galerucella* beetles, a biological control, were released at the Sioux River Sloughs in 2000 and the Bad River Tribe is currently weighing control options for the Beartrap Creek site. The Bad River corridor was treated for the first time in 2000 after the survey was conducted. Changes in loosestrife abundance detected along the Bad River probably resulted from natural erosion along the river's banks.

Overall, it appeared that chemical control efforts have been used successfully to reduce the abundance and areal extant of purple loosestrife where these measures have been employed on a consistent annual basis. The increase in the density of Class I plants at these sites illustrates the point that chemical control is a long term commitment and the decision to use this method requires careful consideration of this fact prior to implementation. GLIFWC proposes to continue the use of chemical control on small sites that are the easiest to eradicate and to use biological controls where large populations would dictate a substantial annual commitment to treat with herbicides.

Table 2. Change in number of populations and density from 1994-2000 for purple loosestrife in the Bad River - Chequamegon Bay watershed.

Location	No. Populations	Area (acres)	Density (plants/m^2)			
			Class I[a]	Class II[b]	Class III[c]	Total
Highway 13 North	-58	-10.4	37.6	-271.0	-60.6	-267.8
Highway 13 South	0	-11.2	160.7	10.5	19.7	190.6
Bad River	-29	-0.7	61.2	7.5	32.7	101.4
Beartrap Creek	-4	0.5	33.6	-22.7	-1.0	7.3
County Rd. A	0	-0.2	121.1	-7.1	-1.4	125.6
Highbridge	-5	-144.5	-0.4	0.9	7.6	9.2
Honest John	-2	-2.6	1.0	-0.2	6.4	7.2
Kakagon Sloughs	-6	-110.4	27.0	3.6	0.3	14.9
Marengo River	-13	0.0	25.0	-2.0	1.0	24.0
Silver Creek	-2	-92.3	52.3	9.1	35.0	136.4
Highway 169	0	0.0	-17.0	-5.0	-3.0	-25.0
Highway 2	-1	0.0	0.0	-0.2	0.0	-0.2
Totals	-120	-371.8	+502.1	-276.6	+36.7	+323.6

a Small scattered plants with 1-5 flowering stems/rootstock.
b Mature plants with ≥ 10 flowering stems/rootstock, clumps sometimes forming aggregate floral masses.
c Aggregates closing to form large monospecific patches or stands.

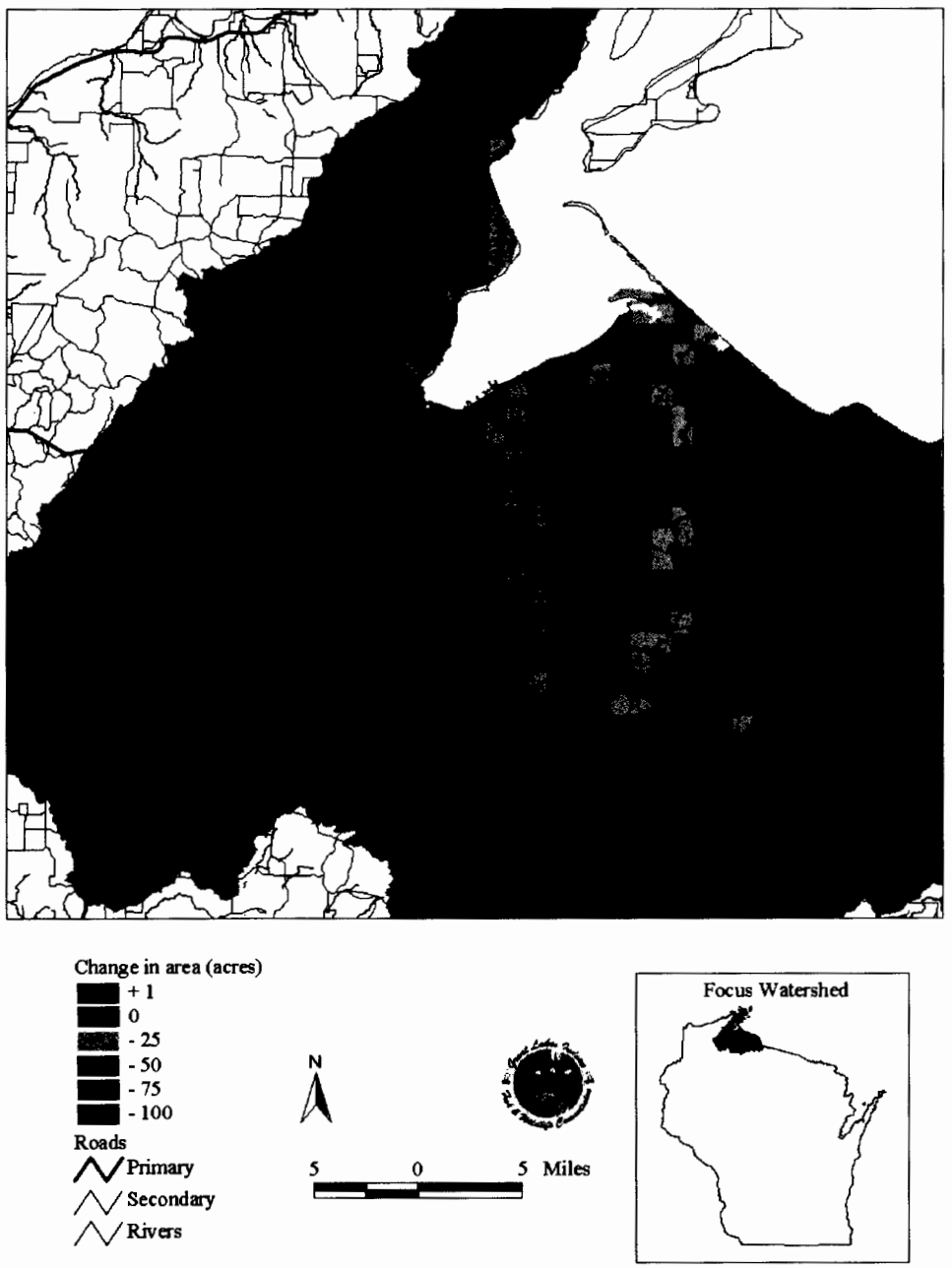

Figure 4. Change in areal extant of purple loosestrife by section, 1994-2000.

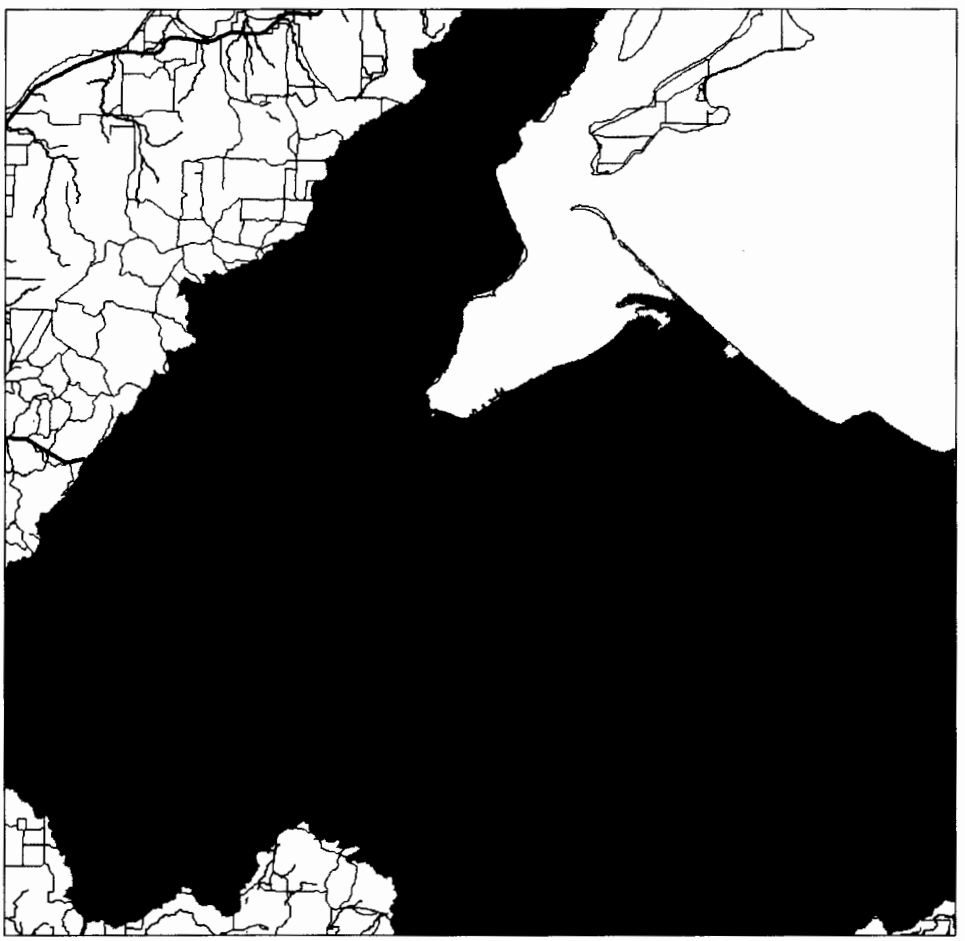

Figure 5. Change in number of purple loosestrife populations by section, 1994-2000.

CONTROL ACTIVITIES IN THE BAD RIVER-CHEQUAMEGON BAY WATERSHED

METHODS

Purple loosestrife populations within the Bad River - Chequamegon Bay watershed were inventoried in 1994, 1995, 1999, and 2000 (Gilbert et al. 1995, Edblom et al. 1995, Falck et al. 2000). Data from these surveys were used to prioritize effort and select control methods based on the area of the site, number of plants, and the site's location within the watershed. Small sites with few plants that threatened to infest downstream reaches were given the highest priority for chemical control (Figure 6). Large sites ($\geq$ 1 acre or $\geq$ 1,000 plants) were given low priority for chemical control but high priority for biological control (Figure 6).

Chemical Control:

Prior to conducting field applications of herbicide, all loosestrife control workers attended a 1 day training workshop conducted by GLIFWC staff. Participants learned or reviewed safe handling, storage, and application procedures, applicable state and federal regulations, and received training on equipment operation and maintenance.

Herbicides were applied to loosestrife stands using back pack sprayers. Glyphosate, a non-selective herbicide, was used in very dense stands or over-water. The dicot-specific herbicide triclopyr was used on dry sites including road-side ditches and fields. Efforts were focused primarily on Fish Creek Sloughs, and the highway 13 right-of-way between Highbridge and Washburn. Private uplands in the Highbridge area were treated primarily by staff from TNC with assistance from the GLIFWC crew after consent forms were signed by the landowner.

Biological Control:

In 2000, GLIFWC initiated a biological control program, rearing approximately 70,000 *Galerucella* beetles for distribution within the watershed. The release of *Galerucella* beetles (native to Europe) in the United States for biological control of purple loosestrife was approved by USDA - APHIS in 1992. The beetles were reared following methods outlined by Loos and Ragsdale (1998). Mature purple loosestrife root stock was transplanted into pots from a population on WI DNR property at the mouth of the Sioux River. The UW-Extension's Ashland Agricultural Research Station provided space for rearing the *Galerucella* beetles. Ninety potted plants were placed in small wading pools filled with 4-6 inches of water. In late May and early June, adult *Galerucella* beetles were collected from previous release sites and placed on the potted plants. Approximately 10 beetles were placed on each plant and a mesh net bag was placed over each plant to protect the beetles and larvae from bird and insect predation (Figure 7). An estimated 750 adult beetles were reared in each pot.

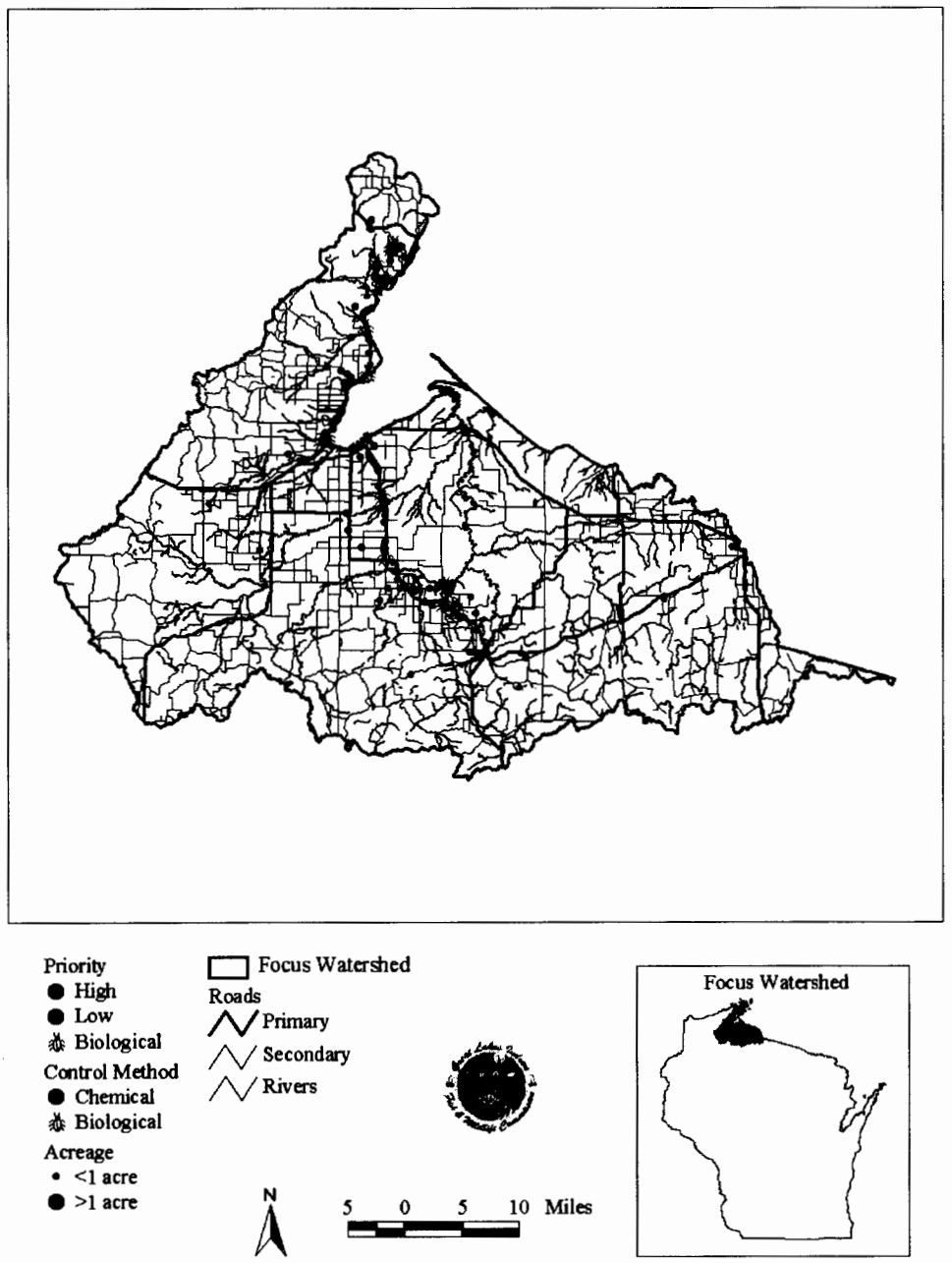

Figure 6. Control priority and method for off-reservation purple loosestrife sites, 2000.

Figure 7. Rearing *Galerucella* beetles.

Evaluation

Spatial data collected during annual surveys were used to quantify the progress of control efforts. Treated loosestrife patches were identified on maps and coded for control in 2000. Each *Galerucella* release site was photographed during the peak of purple loosestrife's blooming period to document the pre-treatment condition of each site. Summary statistics of treated patches were determined with ArcView GIS.

RESULTS

A total of 88 sites comprising 46 acres of purple loosestrife were treated in 2000. Biological control was used on 14 sites comprising 6 acres, and chemical controls were applied to 74 sites comprising 40 acres (Figure 8). A partnership between the Natural Resources Conservation Service (NRCS), The Nature Conservancy (TNC), and GLIFWC helped provide funding for control work on private lands within the watershed. GLIFWC crews treated 35 sites comprising 6 acres and TNC crews treated 53 sites comprising 40 acres (Figure 8).

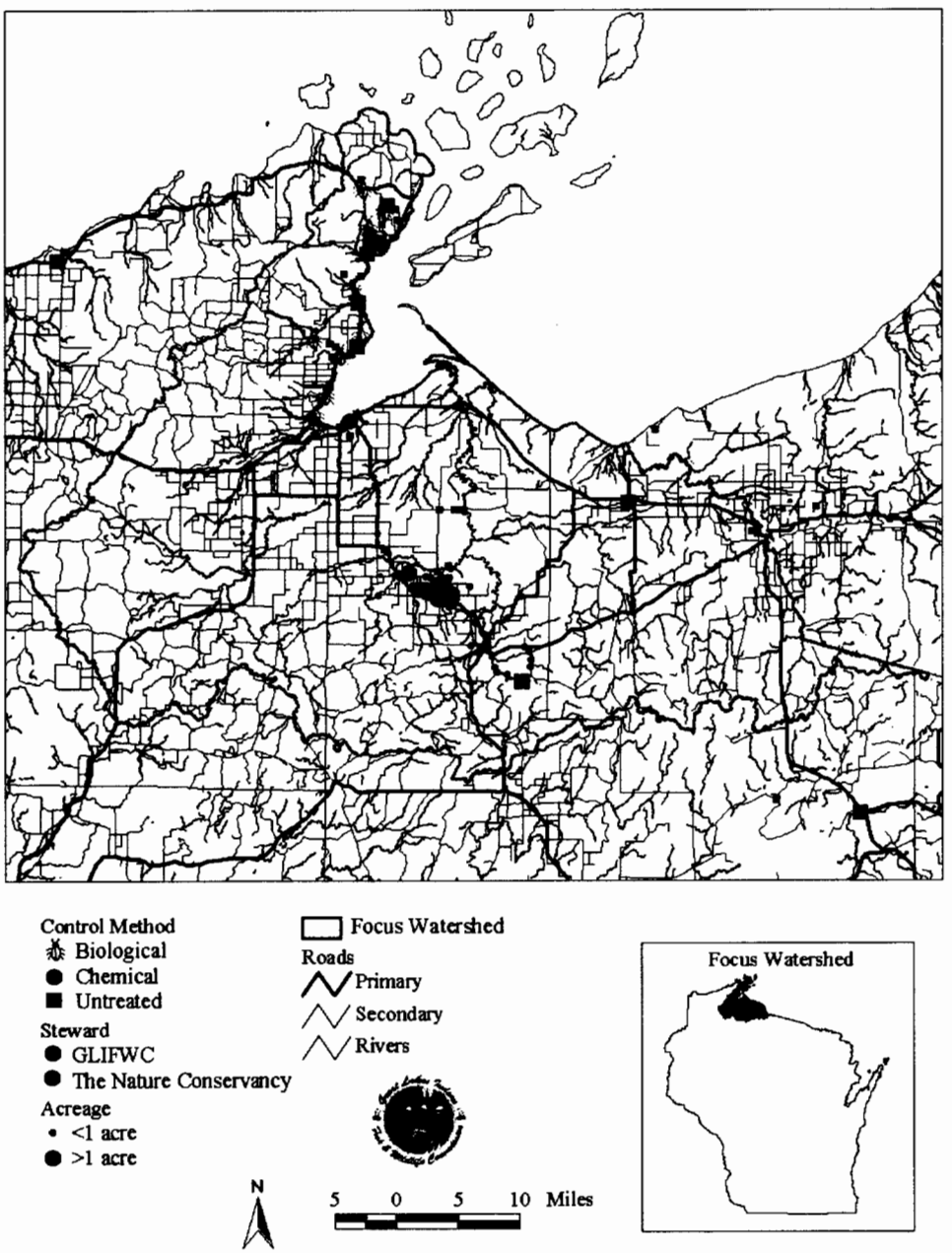

Figure 8. Purple loosestrife control activity in the Bad River - Chequamegon Bay watershed, 2000.

The addition of biological control as a management tool has allowed GLIFWC to expand the scope of its control efforts significantly because the application of biological controls requires far less time than chemical control methods. In addition, one-time applications of biological controls are far more palatable to private landowners who have concerns about annual treatments with herbicides. The result has been significantly increased cooperation from private landowners.

FUTURE WORK

In 2001, GLIFWC plans on expanding its biological control efforts and continuing to use chemical controls on small isolated populations that can be easily eradicated. All biological control sites will be monitored closely for overwinter survival and relative loosestrife density to evaluate the effectiveness of this treatment method.

EXOTIC PLANT EDUCATION AND OUTREACH ACTIVITIES

BACKGROUND

Human activities are responsible for the vast majority of new introductions of invasive non-native plants. Unfortunately, the general public is largely unaware of the negative ecological impacts caused by invasive weeds and the role humans play in their spread. Consequently, numerous invasive plants continue to be dispersed across the landscape by people enjoying outdoor activities. Therefore, effective weed prevention and control is dependent upon the cooperation and assistance of an informed public. To address this problem, GLIFWC implemented an educational outreach program in 1998 that provided current and relevant information to inform the general public of this important issue and the steps to take to minimize the spread of exotic plants.

PROGRAM OVERVIEW

A suite of educational materials was utilized during 2000 to reach a broad range of audiences. This material included brochures, slide presentations, and a comprehensive website that highlighted several exotic plant species of concern in the upper Great Lakes region. GLIFWC distributed brochures and slide shows to the public primarily via cooperating state, federal, county, and tribal resource management agencies throughout the upper Great Lakes region. Other audiences were reached through our website (www.glifwc.org/epicenter/) which has received over 1,900 visits since July 2000. In addition, several presentations were conducted over the summer in conjunction with local environmental events.

ACCOMPLISHMENTS

Brochures

Over 2,400 purple loosestrife brochures were distributed to cooperating resource management agencies, non-government organizations, and private citizens (Table 3). A new brochure/poster titled *Plants Out Of Place* was completed with the editorial and financial assistance of several county, state, and federal agencies, non-government organizations, and private companies (Table 4). The poster provides general information on the ecological, social, and economic impacts of invasive non-native plants in general and how they spread across the landscape. The reverse side highlights several invasive plants of concern in the upper Great Lakes and provides suggestions for slowing their spread and contact information for more information. *Plants Out Of Place* received a warm welcome from resource professionals working to spread the word about exotic plants and over 46,000 were distributed in 2000 (Table 4).

Table 3. Summary of purple loosestrife brochure distribution, 2000.

Organization	No. Brochures
Apostle Islands National Lakeshore	100
TNC- Ashland	100
TNC - MI	150
Michigan Technological University	200
Polk County Land & Water Dept.	200
Hiawatha National Forest	250
WI DNR - Superior	300
Adopt-A-Lake, UWSP	550
UW Extension	600
Total	2,450

Outreach

Over 500 people attended presentations by GLIFWC staff at local events (Table 5). Most of the presentations consisted of the slide show *What You Should Know About Purple Loosestrife* followed by a 15 minute discussion period. A purple loosestrife display was also set up at many of the engagements and brochures were made available for participants to take with them.

REMAINING NEEDS

In addition to purple loosestrife, there are scores of additional exotic plants present throughout the upper Great Lakes region. However, they vary in their impact to natural ecosystems and feasibility of control. GLIFWC staff are currently evaluating these species to determine which ones pose the greatest threats to local ecosystems and have the greatest likelihood for successful control. Preliminary results suggest that spotted knapweed, leafy spurge, garlic mustard, bush honeysuckles, and buckthorn will rank in the top ten for species which merit additional management activities.

A need for additional educational materials is anticipated for those species that rank high in the evaluation and for which suitable educational materials are presently unavailable. The development of additional educational materials will begin in 2002 and will follow the same process used for purple loosestrife:

1) searching for and acquiring existing educational materials if available
2) identifying gaps in existing educational efforts
3) identifying the most appropriate audience to target
4) selecting appropriate media formats
5) translating scientific documents into language suitable for a general audience, and
6) presenting the information in an organized and visually appealing format

Table 4. Partners and distributors of brochure/poster *Plants Out Of Place*, 2000.

Organization / Agency	Partner/Distributor	# Brochures
USFWS	Distributor	50
Sigurd Olsen Environmental Institute	Distributor	50
Adopt-A-Lake, UWSP	Distributor	100
St. Croix Band	Distributor	100
Bad River Band	Distributor	100
Bay Mills Indian Community	Distributor	100
Cable Natural History Museum	Distributor	100
Sokaogon Chippewa Community	Distributor	100
Fond du Lac Reservation	Distributor	100
Lac Courte Oreilles Band	Distributor	100
Red Cliff Band	Distributor	100
Northern Forest Restoration Workshop	Distributor	100
Keweenaw Bay Indian Community	Distributor	100
Lac Vieux Desert Band	Distributor	100
Lac du Flambeau Band	Distributor	100
Mille Lacs Band	Distributor	100
Apostle Islands National Lakeshore	Distributor	200
Michigan Technological University	Distributor	200
Northern Great Lakes Visitor Center	Distributor	300
UW Extension	Distributor	500
Polk County Land & Water Dept.	Distributor	500
ACE High School	Partner	600
Vilas Co. Land, Air & Water Conserv. Dept.	Partner	600
GLIFWC	Partner	900
Applied Ecological Services	Partner	1,000
Wis. Electric & Power Co.	Partner	1,000
Mich. Assoc. of Conserv. Dists.	Partner	1,000
NRCS	Partner	1,020
The Nature Conservancy	Partner	2,250
MN DNR	Partner	3,000
Chequamegon-Nicolet National Forest	Partner	3,000
Huron-Manistee National Forest	Partner	3,000
PRI-RU-TA RC, & D	Partner	3,000
Ottawa National Forest	Partner	3,000
Hiawatha National Forest	Partner	3,000
WI DOT	Partner	3,000
MI DEQ	Partner	4,000
WI DNR	Partner	4,900
MI DNR	Partner	5,000
Total		46,470

Table 5. Summary of educational outreach engagements , 2000.

Event / Location	Location	Sponsor	Date	Attendance
Home & Garden Show	Ashland Civic Center	GLIFWC	04/01/00	> 100
Environmental Extravaganza	Ashland High School	Northland College	04/08/00	> 50
Earth Day	Northern Great Lakes Visitor Center	GLIFWC	04/21/00	> 100
Celebrating Wildlfowers Day	Northern Great Lakes Visitor Center	GLIFWC	05/27/00	> 50
Biological Control Workshop	Ashland Agricultural Research Station	GLIFWC	06/03/00	2
Landscaping With Wildflowers	Northern Great Lakes Visitor Center	GLIFWC	07/08/00	12
Ashland County Fair	Ashland County Fair Grounds	Ashland County 4-H	07/13/00	> 100
Bayfield County Fair	Bayfield County Fair Grounds	Bayfield County 4-H	08/10/00	> 100
Total				> 514

COORDINATION WITH OTHER AGENCIES AND ORGANIZATIONS

An ad hoc forum called the "Northwoods Weed Initiative" (NWI) has met regularly to share information, coordinate activities, and discuss future collaborations to address invasive non-native plants in northern Wisconsin and Michigan. Participants include GLIFWC, Lac Courte Oreilles Band of Lake Superior Ojibwa, the Chequamegon-Nicolet National Forest, the Ottawa National Forest, The Nature Conservancy, PRI-RU-TA RC & D, the Natural Resources Conservation Service, and the WI DNR. The Northwoods Weed Initiative recognizes the inherent problems (i.e. labor intensive, cross jurisdictional boundaries, etc.) associated with managing invasive exotic plants and strives to address these obstacles by working together in a coordinated manner (see Appendix A).

In 2000, NWI was instrumental in completing the *Plants Out Of Place* poster/brochure described above. In addition, NWI helped organize a regional conference on invasive non-native plants in Eau Claire, WI. GLIFWC staff were responsible for administering the conference web site. Plans are currently being developed to revise several agency technical guidelines that provide guidance for re-vegetation and erosion control activities. NWI participants plan to review these documents to insure that the use on non-native plants are not encouraged and suggest revisions where appropriate.

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GLC #5572-E)

Invasive Non-native Plant Management During 2001

by

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and

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Administrative Report 02-08
September 30, 2002

Great Lakes Indian Fish
& Wildlife Commission
Biological Services Division
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EXECUTIVE SUMMARY

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an organization exercising delegated authority from 11 federally recognized tribes in Minnesota, Wisconsin, and Michigan (Figure 1). These tribes retain hunting, fishing, and gathering rights in the territories ceded to the United States through various treaties (Figure 1). The exercise of these rights may be threatened by the degradation of native ecosystems by invasive non-native plants.

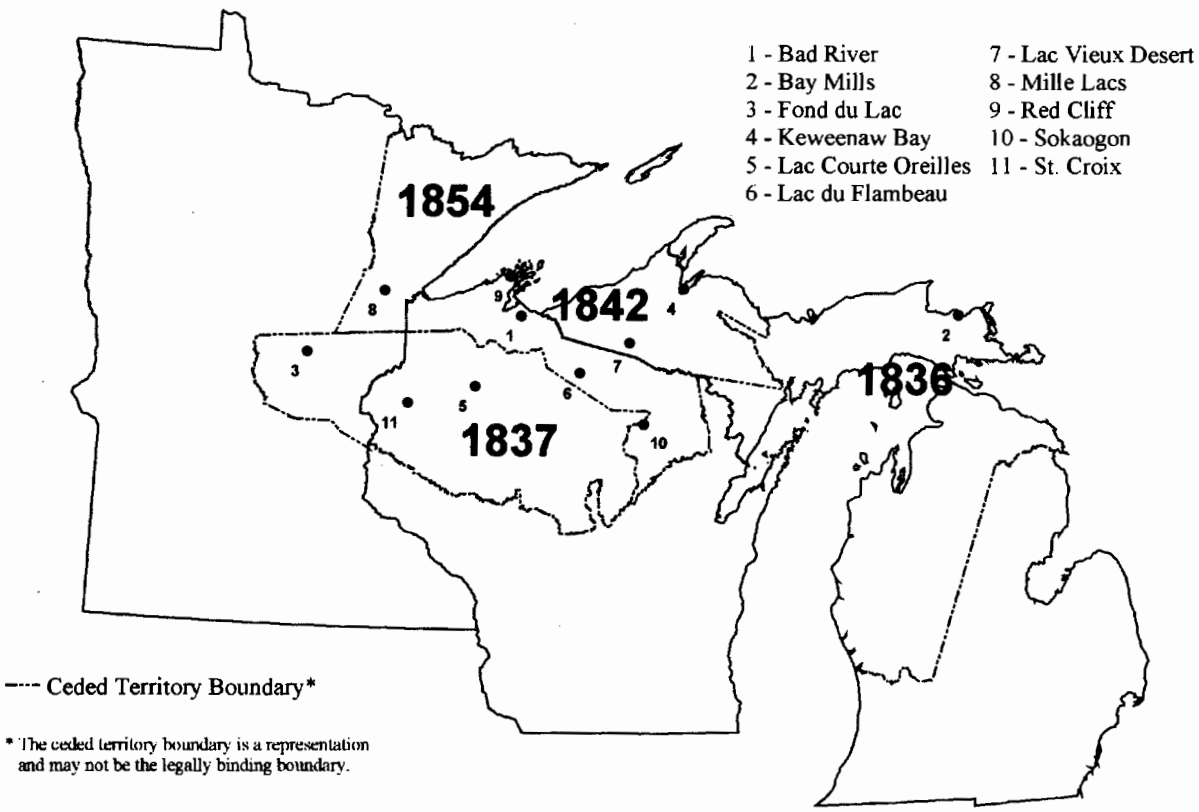

Figure 1. Locations of GLIFWC member tribes and ceded territories.

This report summarizes the activities undertaken by GLIFWC staff during 2001 to address the spread of invasive non-native plant species in the ceded territories. Since 1988, GLIFWC staff have conducted annual inventory and control work on purple loosestrife (*Lythrum salicaria*) (Gilbert and Parisien 1989, Edblom *et al.* 1995, Gilbert *et al.* 1995, Gilbert *et al.* 1998, Falck *et al.* 1999, Falck

et al. 2000, Falck 2001). In 2001, GLIFWC staff identified the need to 1) continue and expand purple loosestrife control activities, 2) inventory and assess the threat of other non-native plants that are becoming established in the region, 3) continue educational outreach activities aimed at preventing the introduction and spread of additional non-native plants, and 4) continue to coordinate activities with cooperating resource agencies, universities, non-governmental organizations, and the general public. Vascular plant nomenclature cited in this report follows Gleason and Cronquist (1991).

ACKNOWLEDGMENTS

The activities summarized in this report were partially funded by the Bureau of Indian Affairs' Noxious Weed Program (BIA), the Environmental Protection Agency's Great Lakes National Program Office (EPA-GLNPO), the Natural Resources Conservation Service's Environmental Quality Incentive Program (NRCS-EQIP), NRCS-EQIP Multi Agency Land & Water Education Grant Program, and The Nature Conservancy (TNC).

PURPLE LOOSESTRIFE CONTROL ACTIVITIES IN THE BAD RIVER-CHEQUAMEGON BAY WATERSHED

INTRODUCTION

Purple loosestrife (*Lythrum salicaria*) is a perennial, herbaceous wetland plant native to Europe. It arrived in eastern North America in the early 1800's via plants brought by settlers and seeds carried within livestock and the ballast holds of ships (Thompson *et al.* 1987). In North America, purple loosestrife quickly spread westward displacing native wetland plant communities. Its current distribution covers much of the U.S. and Canada. GLIFWC has been treating purple loosestrife within the Bad River - Chequamegon Bay watershed since 1988. The Nature Conservancy (TNC) has been contributing to this effort in cooperation with GLIFWC since 1998 with an emphasis on private lands in the upper reaches of the watershed.

METHODS

Purple loosestrife populations within the Bad River - Chequamegon Bay watershed were inventoried in 1994, 1995, 1999, and 2000 (Gilbert *et al.* 1995, Edblom *et al.* 1995, Falck and Sutton 2000, Falck 2001). Data from these surveys were used to prioritize effort and select control methods based on the area of the site, number of plants, and the site's location within the watershed. Small sites with few plants (< 1 acre or < 1,000 plants) that threatened to infest downstream reaches were given the highest priority for chemical control (Figure 2). Large sites (> 1 acre or > 1,000 plants) were given low priority for chemical control but high priority for biological control (Figure 2).

Chemical Control:

Prior to conducting field applications of herbicide, all loosestrife control workers attended a 1-day training workshop conducted by GLIFWC staff. Participants learned or reviewed safe handling, storage, and application procedures, applicable state and federal regulations, and received training on equipment operation and maintenance.

Herbicides were applied to loosestrife stands using backpack sprayers. Glyphosate, a non-selective herbicide, was used in very dense stands or over water. The dicot-specific herbicide triclopyr was used on dry sites such as roadsides and fields. Efforts were focused primarily on the Fish Creek Slough, and the Highway 13 right-of-way between Highbridge and Washburn. Private uplands in the Highbridge area were treated primarily by staff from TNC with assistance from the GLIFWC crew, after consent forms were signed by the landowner.

Biological Control:

The release of *Galerucella* beetles (native to Europe) in the United States for biological control

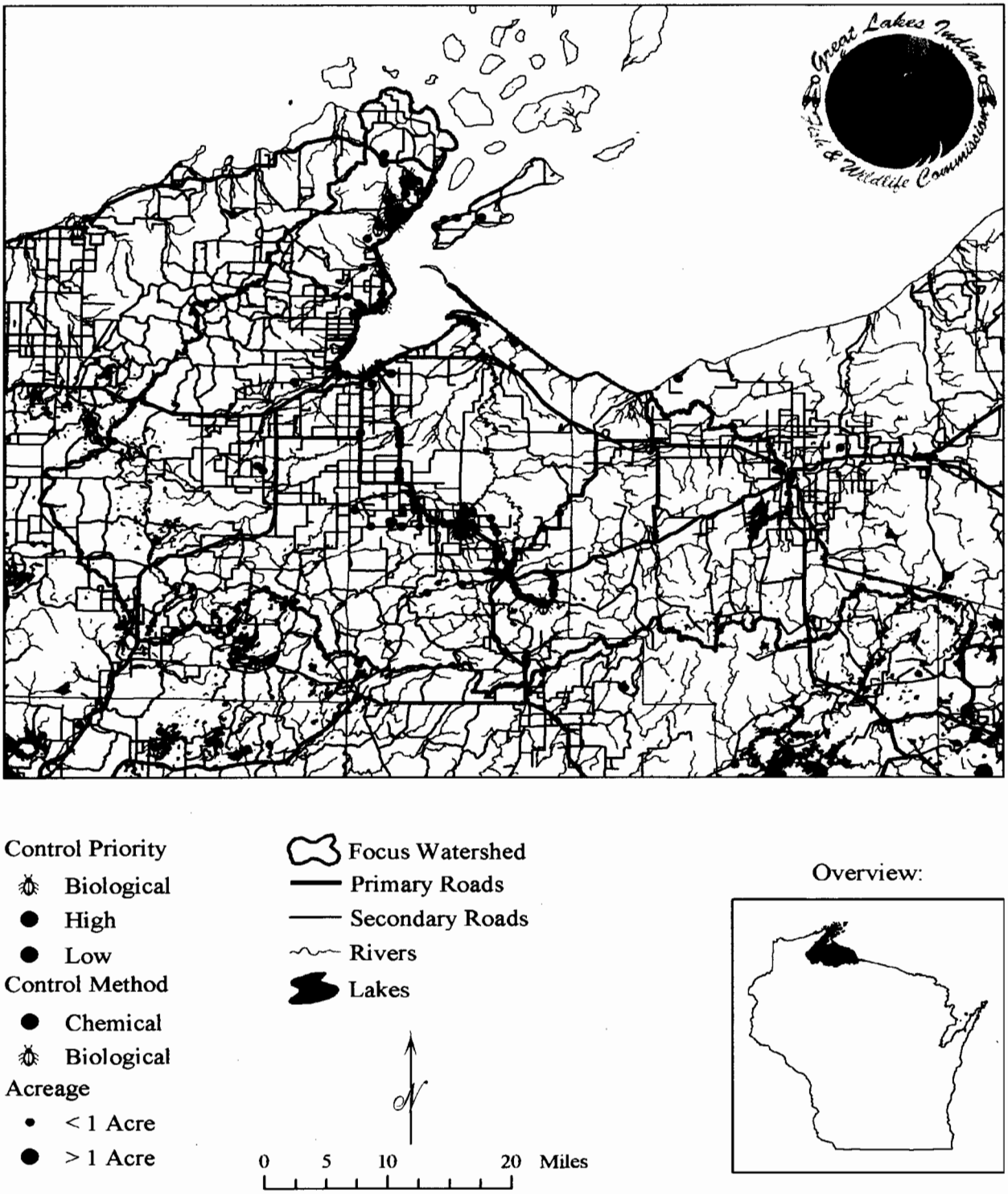

Figure 2. Control priority and method for off-reservation purple loosestrife sites, 2001.

of purple loosestrife was approved by USDA - APHIS in 1992. *Galerucella* beetles were reared following methods outlined by Loos and Ragsdale (1998). Mature purple loosestrife root stock was transplanted into pots from a population on Wisconsin DNR property, at the mouth of the Sioux River. The UW-Extension's Ashland Agricultural Research Station provided space for rearing *Galerucella* beetles. One hundred sixty potted plants were placed in small wading pools containing 4-6 inches of water. In late May and early June, adult *Galerucella* beetles were collected from previous release sites and placed on the potted plants. Approximately 10-12 beetles were placed on each plant, which were enclosed in individual mesh net bags to protect the beetles and their larvae from bird and insect predation. An estimated 750 adult beetles (Brock Woods, WI DNR, pers. comm.) were reared in each pot.

Evaluation

Spatial data collected during annual surveys were used to quantify the progress of control efforts. Treated loosestrife patches were identified on maps and coded for control in 2001. Each *Galerucella* release site was photographed during the peak of purple loosestrife's blooming period to document the pre-treatment condition of each site. Summary statistics for treated patches were calculated using ArcView GIS.

RESULTS

A total of 109 sites were treated in 2001. GLIFWC crews released approximately 122,000 *Galerucella* beetles among 7 sites and treated another 62 sites with herbicide, while TNC crews applied herbicide at 40 additional sites (Figure 3). The success of biological controls was evaluated at the 16 sites where beetles were introduced in 2000. *Galerucella* beetles successfully overwintered at all 16 sites, and a reduction in loosestrife flowering was visually apparent at 2 of these sites (Figures 4 and 5).

DISCUSSION AND FUTURE WORK

The use of biological controls has expanded the acreage treated annually by GLIFWC's purple loosestrife control program and allowed control crews to place more emphasis on treating small roadside populations with herbicide before they become significant source populations. Increased production of *Galerucella* beetles in 2002 will enable GLIFWC to expand biocontrol efforts beyond the Bad River - Chequamegon Bay watershed.

Regional coordination of control efforts will benefit from GLIFWC's participation in the Wisconsin Wetland Association's new statewide survey to update purple loosestrife distribution data and digitize existing biocontrol sites. GLIFWC will host this data on its Internet map server (www.glifwc-maps.org). Data from Minnesota and Michigan will be added in 2002 as well.

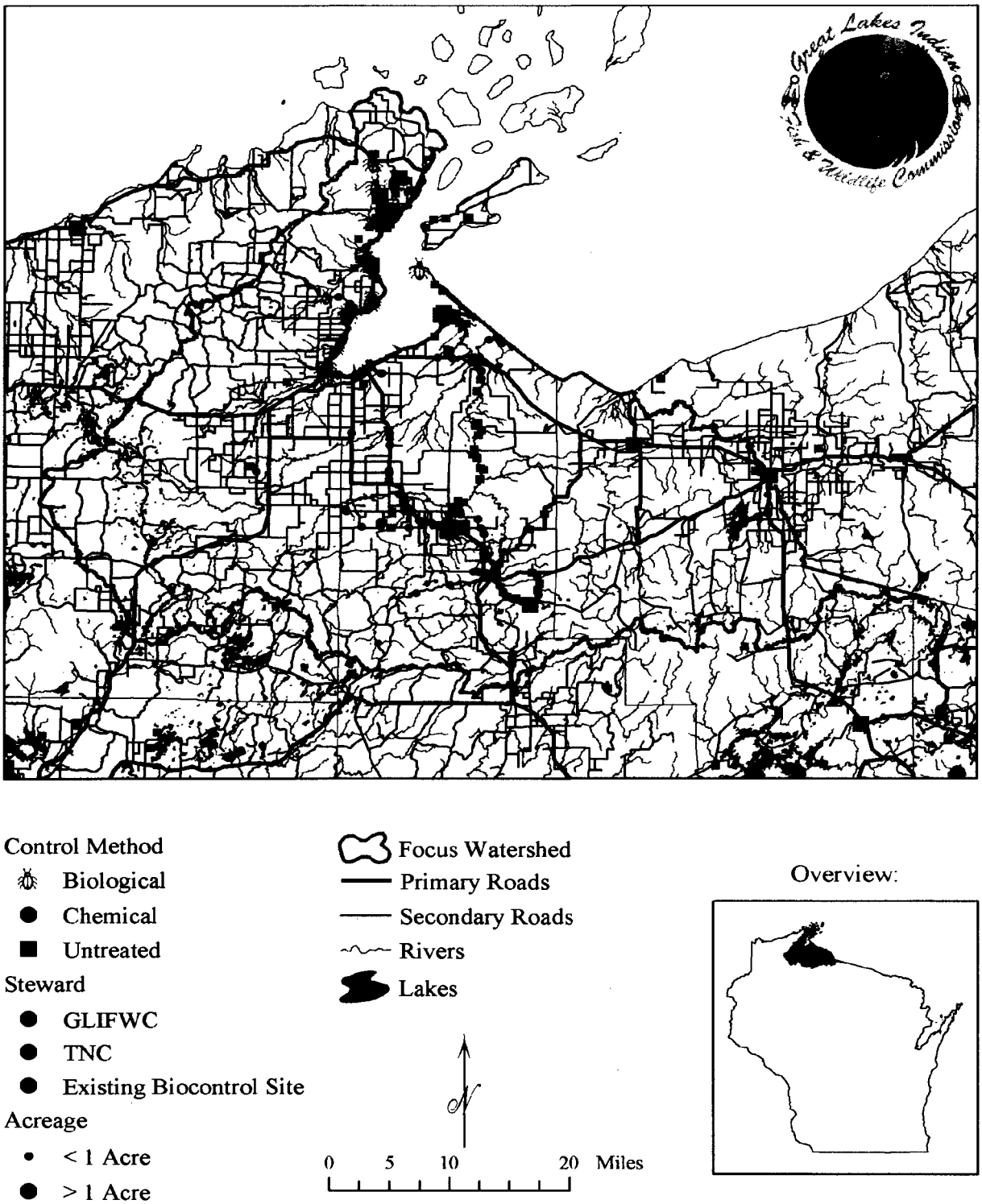

Figure 3. Purple loosestrife control activities in the Bad River-Chequamgeon Bay watershed, 2001.

Figure 4. Comparison of purple loosestrife flowering in 2000 vs. 2001 at Washburn site following release of *Galerucella* beetles in July, 2000.

Figure 5. Comparison of purple loosestrife flowering in 2000 vs. 2001 at Bayfield site following release of *Galerucella* beetles in July, 2000.

INVASIVE PLANT SURVEY

INTRODUCTION

In addition to purple loosestrife, GLIFWC recognizes that a multitude of other non-native plant species are present within the ceded territories. Some of these pose serious risks to the integrity of local ecosystems. Besides physical displacement of native flora and fauna, non-native plants can alter fire frequency, hydrologic properties, soil chemistry, and the structure and function of entire ecosystems (Westbrooks 1998).

Non-native plants vary substantially in their impacts and feasibility of control. Management of these plants will require an accurate inventory, objective prioritization criteria, and an array of effective integrated control methods. To help address these needs, GLIFWC conducted a survey of Ashland and Bayfield counties in the summer of 2001, to determine the composition, relative abundance, and distribution of non-native invasive plants. The information will be compiled with data from published literature and other sources, to develop a database that can be used to prioritize species for future management.

METHODS

The survey targeted the most likely areas for non-native plant introductions. Road corridors were surveyed from a vehicle while sites with high visitation rates (e.g. boat landings, trail-heads, parks) and sites with potential to serve as source populations (e.g. old homesteads, gravel pits) were surveyed on foot. Surveys were conducted throughout the growing season and most routes were re-surveyed to account for the different phenology of various species. While road corridor surveys have obvious shortcomings, such surveys can still be informative (Mack 2000, Brown *et al.* 2001). The biggest advantage is being able to cover a large territory in a relatively short amount of time. Roadsides are a logical place to survey for non-native plants because they often act as corridors, facilitating invasion of disturbance-dependent species (Heckman 1999, Parendes and Jones 2000, Brown *et al.* 2001).

The locations of non-native plant populations were determined using a hand held GPS receiver. Data files were then differentially corrected and exported as shapefiles for use in ArcView GIS. Where satellite signals were unavailable, locations were plotted on a map and later digitized manually using ArcView GIS. Attributes for each site were recorded using the receiver's "data dictionary" (Table 1).

Voucher specimens intended for herbarium accession were collected from selected populations, depending on how "unique" the population was relative to its known distribution. These were submitted to the Wisconsin State Herbarium, University of Wisconsin - Madison

Table 1. Site attributes collected during the 2001 invasive plant survey.

Attribute	Categories
Area	living room (0.004 Acres) baseball diamond (0.200 Acres) football field (1.00 Acres) > football field (> 1.00 Acres)
Number of Plants	<50 50-1000 >1000
Habitat	open shoreline wooded woodland edge
Hydrology	dry mesic seasonally wet wet
Land Use	agricultural natural area right-of-way urban
Disturbance	construction cultivation foot traffic logging motorized traffic mowing unknown
Land Ownership	county federal local municipality private state tribal

(WIS), the University of Wisconsin - Oshkosh Herbarium (OSH), and/or GLIFWC's herbarium in Odanah. Numerous photographs were also taken of both native and non-native plant species during the course of the survey for use in developing educational materials. The location, date, and subject of each photo was recorded for future reference.

RESULTS AND DISCUSSION

Overview

Unfortunately, Ashland and Bayfield counties have not escaped the worldwide influx of invasive, non-native plants. A number of significant or serious invasives [*e.g.*, spotted knapweed (*Centauria maculosa*), common tansy (*Tanacetum vulgare*)] have already become so common and widespread (at least along roadsides) throughout most or nearly all of the survey area, that it was not practical to record their presence (Table 2) [Purple loosestrife was not recorded because comprehensive distribution data has already been obtained for this plant in the project area (Gilbert *et al.* 1995, Edblom *et al.* 1995, Falck and Sutton 2000, Falck 2001)]. However, most of the invasive plants documented during this survey have not yet reached anywhere near their potential in terms of frequency or abundance. Some of the most ecologically invasive species noted during this survey are discussed briefly below.

Approximately 1,780 km of roadsides, 39 recreational sites (campgrounds, parks, and trail-heads), and 99 boat landings were surveyed for the presence of non-native plants (Figure 6). A total of 882 non-native plant populations were recorded (Figure 7) representing 59 taxa (Table 3). Genera most frequently encountered included *Salix* (18%), *Lonicera* (13%), *Rhamnus* (10%), *Coronilla* (10%), *Lathyrus* (8%), *Euphorbia* (6%), and *Valeriana* (4%). Similarly, comparison of acre class midpoints revealed that *Salix* occupied the most area, followed by *Rhamnus*, *Lonicera*, *Lathyrus*, *Euphorbia*, and *Valeriana*. Non-natives plants were most often found along woodland edges (52%), followed by open areas (36%), wooded areas (7%), and shorelines (5%). Figure 8 depicts those species encountered most frequently by habitat.

Well-established, major invasives

Two Eurasian buckthorn species almost certainly rank among the most serious invasives found in the survey area. Although common buckthorn (*Rhamnus cathartica*) typically invades upland sites and glossy buckthorn (*R. frangula*) typically invades wetland sites, there can be substantial habitat overlap. Both are aggressive, shade-tolerant shrubs that can rapidly invade natural ecosystems, displace natural vegetation, and even prevent the establishment of tree seedlings (Catling and Porebski 1994, Archibold *et al.* 1997, Czarapata 1999). While the berries of these two species are attractive to birds, their diarrhetic qualities can result in a net energy loss (Czarapata 1999). Both species have become major problems throughout much of the eastern US and adjacent Canada, and are increasing in abundance in the upper Great Lakes region.

The survey found that common buckthorn is well-established in woodlots around several towns and cities, including Ashland, Washburn, Bayfield, Highbridge, and Mason. (A substantial patch was also found just south of US Hwy 2, near the Bad River.) Glossy buckthorn is common in Prentice Park

Table 2. Introduced taxa that were too widespread to map effectively during the 2001 survey.

Species	Common Name	Typical Habitat
Agrostis gigantea	Redtop	roadsides, barrens
Arctium minus	Burdock	fields, roadsides, disturbed woods
Bromus inermis	Smooth Brome	fields, roadsides, disturbed woods, wetland edges, barrens
Centaurea maculosa	Spotted Knapweed	roadsides, barrens
Chrysanthemum leucanthemum	Ox-eye Daisy	fields, roadsides, disturbed woods, wetland edges
Cirsium arvense	Canada Thistle	fields, roadsides, disturbed woods, wetland edges
Dactylis glomerata	Orchard Grass	fields, roadsides, disturbed woods
Daucus carota	Queen Anne's Lace	fields, roadsides
Elytrigia repens	Quackgrass	fields, roadsides, disturbed woods, barrens
Festuca arundinacea	Tall Fescue	fields, roadsides, disturbed woods, wetlands
Glechoma hederacea	Creeping Charlie	fields, disturbed woods, wetland edges
Hieracium aurantiacum	Orange Hawkweed	fields, roadsides, disturbed woods, barrens
Hieracium piloselloides	Yellow Hawkweed	fields, roadsides, barrens
Hypericum perforatum	Common St. John's Wort	fields, roadsides, disturbed woods, wetland edges
Linaria vulgaris	Butter and Eggs	fields, roadsides, barrens
Lotus corniculatus	Birds-foot Trefoil	fields, roadsides, barrens
Lupinus polyphyllus	Bigleaf lupine	fields, roadsides, disturbed woods
Melilotus alba	White Sweet Clover	fields, roadsides
Melilotus officinalis	Yellow Sweet Clover	fields, roadsides
Phalaris arundinacea	Reed Canary Grass	fields, roadsides, wetlands
Phleum pratense	Timothy Grass	fields, roadsides, wetland edges
Poa compressa	Canada Bluegrass	roadsides, barrens
Poa pratense	Kentucky Bluegrass	fields, roadsides, disturbed woods, wetland edges
Ranunculus acris	Tall Buttercup	fields, roadsides, disturbed woods, wetland edges
Rumex acetocella	Red Sorrel	roadsides, barrens
Tanacetum vulgare	Common Tansy	fields, roadsides, disturbed woods, wetland edges, barrens
Taraxacum officinale	Dandelion	fields, roadsides, woods, wetland edges
Trifolium pratense	Red Clover	fields, roadsides, disturbed woods
Trifolium repens	White Clover	fields, roadsides, disturbed woods
Verbascum thapsus	Mullein	fields, roadsides, barrens

just west of Ashland and in Memorial Park just north of Washburn. Substantial populations of both species (often growing together) were found just west of the Great Divide District of the Chequamegon-Nicolet National Forest (CNNF), in Bayfield county. It is also well-established along portions of the White River and in surrounding areas of southwestern Bayfield county, on both public and private lands. It is abundant in wetlands on both sides of County Highway H, from Delta northeastward towards Iron River, and has begun to colonize wetland edges within the Great Divide

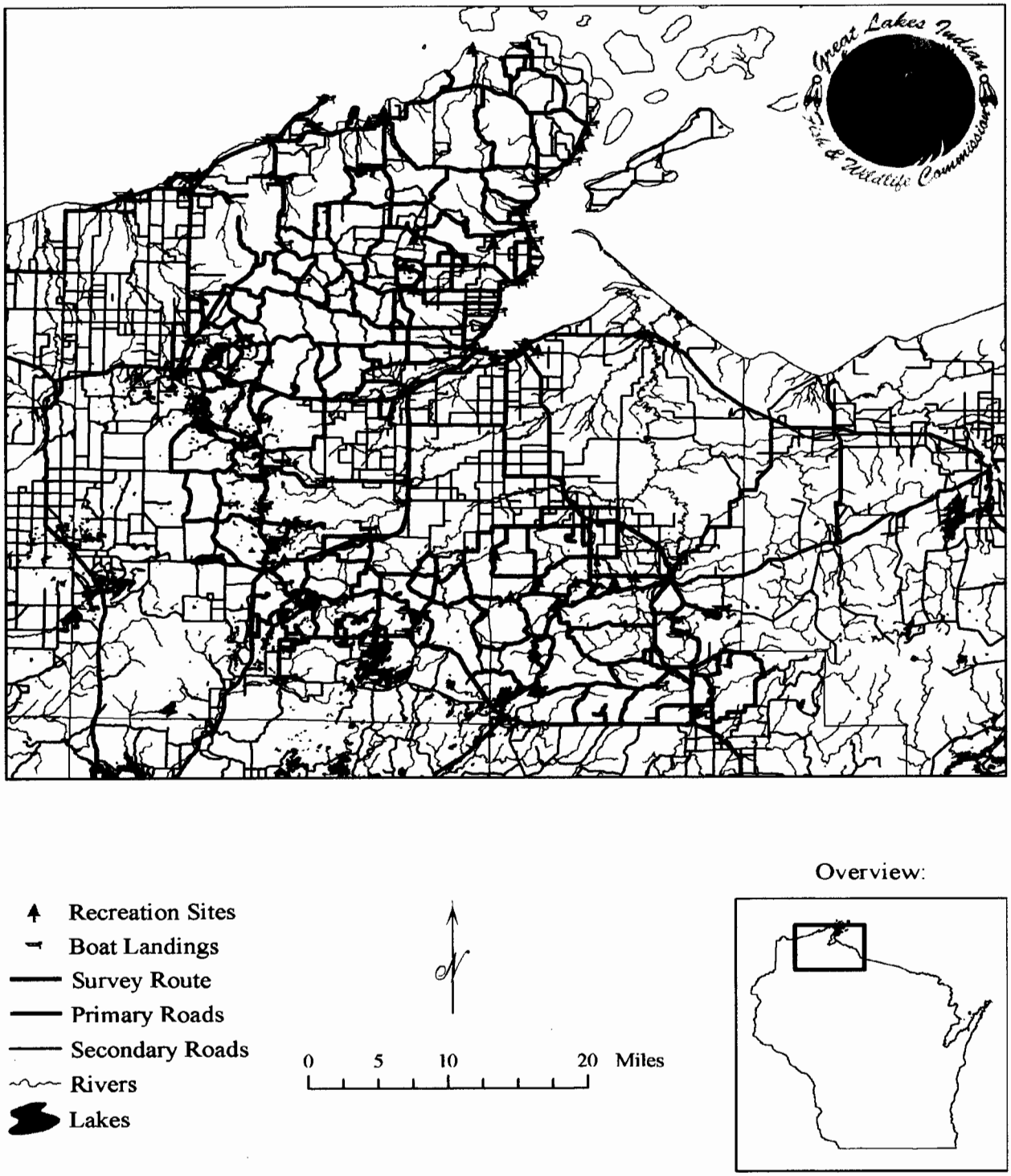

Figure 6. Invasive plant survey route, 2001.

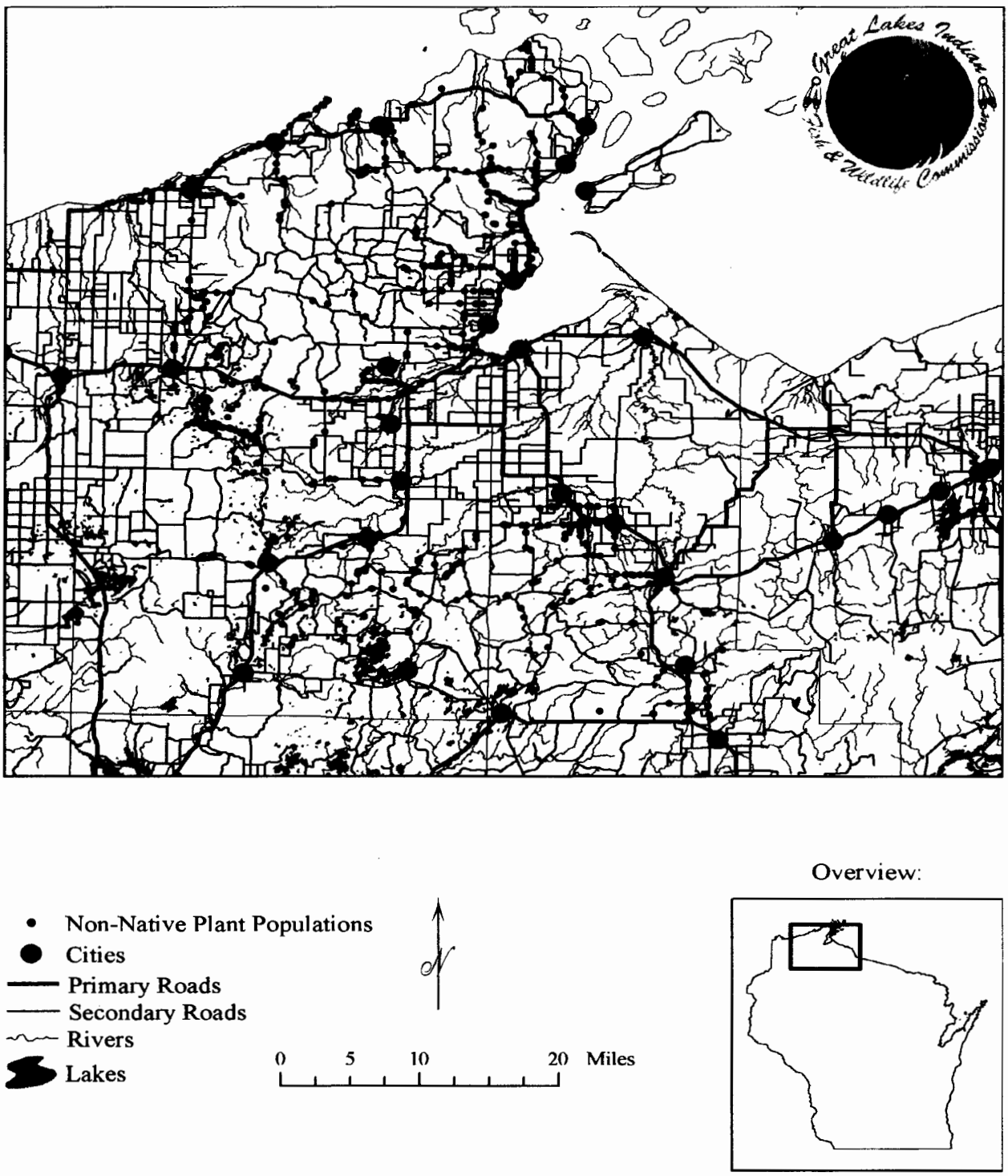

Figure 7. Non-native plant populations detected in 2001.

Table 3. Summary of non-native plant taxa detected during 2001 surveys.

Taxa	Common Name	No. of Sites	Percent of Sites
Salix fragilis	Crack Willow	163	18.5%
Lonicera spp.	Eurasian Bush Honeysuckles	121	13.7%
Coronilla varia	Crown Vetch	92	10.4%
Lathyrus sylvestris	Everlasting Pea	74	8.4%
Rhamnus frangula	Glossy Buckthorn	53	6.0%
Euphorbia esula	Leafy Spurge	50	5.7%
Valeriana officinalis	Garden Heliotrope	41	4.6%
Rhamnus cathartica	Common Buckthorn	39	4.4%
Robinia pseudoacacia	Black Locust	22	2.5%
Veronica officinalis	Common Speedwell	20	2.3%
Anthoxanthum odoratum	Sweet Vernal Grass	19	2.2%
Polygonum sachalinense	Japanese Knotweed	18	2.0%
Lapsana communis	Nipplewort	14	1.6%
Pastinaca sativa	Wild Parsnip	13	1.5%
Solanum dulcamara	Nightshade	11	1.2%
Aegopodium podagraria	Goutweed	9	1.0%
Berberis thunbergii	Japanese Barberry	8	0.9%
Knautia arvensis	Blue Buttons	8	0.9%
Linaria dalmatica	Dalmation Toadflax	8	0.9%
Saponaria officinalis	Soapwort	8	0.9%
Phlox paniculata	Summer Phlox	7	0.8%
Achillea ptarmica	Sneezeweed	6	0.7%
Campanula rapunculoides	Bellflower	6	0.7%
Miscanthus sacchariflorus	Amur Silver Grass	5	0.6%
Vinca minor	Periwinkle	5	0.6%
Convallaria majalis	E. Lilly of Valley	4	0.5%
Setaria faberi	Giant Foxtail Grass	4	0.5%
Sorbus aucuparia	European Mtn. Ash	4	0.5%
Ulmus pumila	Siberian Elm	4	0.5%
Ranunculus repens	Creeping Buttercup	3	0.3%
Rosa spp.	Eurasian Rose	3	0.3%
Acer platanoides	Norway Maple	2	0.2%
Elaeagnus angustifolia	Russian Olive	2	0.2%
Elaeagnus umbellata	Autumn Olive	2	0.2%
Euphorbia cyparissias	Cypress Spurge	2	0.2%
Galium verum	Yellow Bedstraw	2	0.2%
Lathyrus tuberosus	Everlasting Pea	2	0.2%
Malva moschata	Musk Mallow	2	0.2%
Rorippa nasturtium-aquaticum	Water-cress	2	0.2%
Salix alba	White Willow	2	0.2%

Taxa	Common Name	No. of Sites	Percent of Sites
Secale cereale	Perennial Rye	2	0.2%
Sorbaria sorbifolia	False Spiraea	2	0.2%
Viburnum lantana	Wayfaring Tree	2	0.2%
Betula pendula	European White Birch	1	0.1%
Calamagrostis epigejos	Feathergrass	1	0.1%
Caragana arborescens	Siberian Pea Shrub	1	0.1%
Filipendula ulmaria	Queen-of-the-meadow	1	0.1%
Hemerocallis lilioasphodelus	Lemon Daylily	1	0.1%
Iris pseudacorus	Water Flag	1	0.1%
Lathyrus latifolius	Everlasting Pea	1	0.1%
Leonurus cardiaca	Motherwort	1	0.1%
Lychnis viscaria	German Catchfly	1	0.1%
Mentha × gentilis	Scotch Mint	1	0.1%
Rosa eglanteria	Sweetbrier Rose	1	0.1%
Rumex acetosa	Green Sorrel	1	0.1%
Salix pentandra	Bay-leaved Willow	1	0.1%
Thymus pulegioides	Wild Thyme	1	0.1%
Veronica arvensis	Corn Speedwell	1	0.1%

district.

Eurasian bush honeysuckles (including *Lonicera tatarica*, *L. morrowii*, and their hybrid, *L. x bella*) have also become established throughout eastern temperate North America (Schmidt and Whelan 1999). These species were found along road corridors, forest edges, and some interior forest sites throughout much of the survey area, in both wet and dry soils. They also appeared to be spreading from cities, towns, and agricultural areas into natural areas. While not as shade-tolerant as the two buckthorns, they have a wide ecological amplitude and are capable of invading, persisting, and reproducing in disturbed forests, forest edges, wetlands, and even the barrens. Schmidt and Whelan (1999) found that American robin (*Turdus migratorius*) nesting success was significantly lower in nests built in *Lonicera maackii* (another Eurasian bush honeysuckle) and common buckthorn than in native shrub species. Eurasian bush honeysuckles produce relatively energy-poor, low-quality fruits (Williams 1999).

Crack willow, white willow, and presumably their hybrid (*Salix fragilis*, *S. alba*, and *Salix × rubens* Schrank, respectively) proved to be common and apparently spreading in flood plains and wetland edges throughout much of the survey area, particularly in farm country. These willows are often planted as shelterbelts and shade trees along rivers and streams, where they readily spread. While information on the effects of colonization of natural communities by these species in eastern North America appears to be limited, one might reasonably suspect that the addition of a large, fast-growing

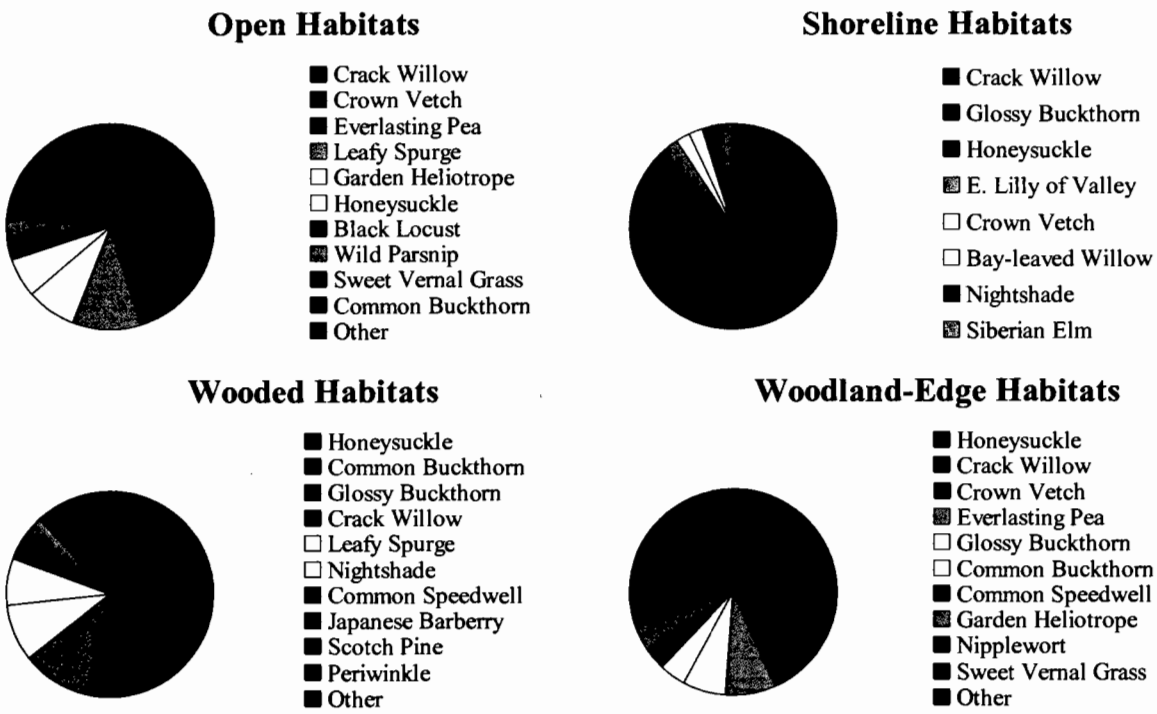

Figure 8. Most frequently observed non-native flora by habitat.

riparian tree species would have significant effects on these communities.

Garden heliotrope (*Valeriana officinalis*) has established widely scattered colonies across much of the survey area, including an extensive roadside infestation just north of Washburn. This species was first introduced into the Duluth-Superior area in 1938 (MINN 2002). It has since become abundant there and appears to be spreading eastward. Scattered infestations were found in Bayfield county, including a large one along Superior Avenue just north of Washburn. A long-time resident there informed us that this population had originated from 3 plants planted in a local garden roughly 60 years ago. This species is moderately shade-tolerant and capable of forming dense stands in open wet woods, moist meadows, and wetlands. It is wind-dispersed and capable of traveling long distances. While little has apparently been published on the invasive tendencies of this weed in North America, our personal observations and experience lead us to include it as an important and potentially major invasive here. Some infestations of this species may still be small and discrete enough to be controlled or eradicated.

A large colony of Dalmatian toadflax (*Linaria dalmatica*) was discovered along the Whiting Road corridor, west of Hwy 13, between Washburn and Bayfield in Bayfield county. This colony extends for roughly 3 miles along both sides of the road, invading adjacent openings and open woods.

This species has become a serious weed of roadsides, rangelands, and disturbed open woods in the western US and Canada (Vujnovic and Wein 1997, Carpenter and Murray 1998). It rapidly invades on course-textured soils, particularly after disturbance. Once established, it is a strong competitor, and difficult to impossible to eradicate. Fortunately, several (moderately effective) biocontrol organisms have been approved for its control (Julien 1992, Carpenter and Murray 1998).

Asian knotweeds (*Polygonum cuspidatum* and *P. sachalinense*) are commonly planted around the survey area (particularly in eastern and northern Bayfield county), and generally spread clonally, forming large patches which eliminate competing species. These species have become important pests across much of temperate North America (Toney *et al.* 1998, Reeder and Eick 2001) and major pests in Britain (Beerling *et al.* 1994). The two species are closely related and capable of hybridizing. Fortunately, their spread in North America (and most of their introduced range) is limited to vegetative dispersal, as only male-sterile (functionally female) forms of each have been introduced (at least so far).

Still-uncommon, major invasives

Japanese barberry (*Berberis thunbergii*) is established in a fairly mature, closed-canopy hardwood forest north of Drummond. This species is already a major understory invasive in eastern deciduous forests (Kourtev *et al.* 1998, Ehrenfeld 1999, Ehrenfeld *et al.* 2001), and has formed several large colonies in western Upper Michigan (Steve Garske, pers. obs.). This very spiny, shade-tolerant species can invade a wide variety of dry to wet forest habitats, sometimes forming dense, impenetrable thickets. Its bright red berries often remain on the plants well into the winter, a reflection of their low nutrient value and unattractiveness to birds (Ehrenfeld 1999). While other populations of this species may well exist undetected within the survey area, it is apparently still uncommon here overall, and may still be amenable to control measures.

Except for occasional yard trees, Norway maple (*Acer platanoides*) was rarely detected during the survey. This is very likely due at least in part to its rather close superficial resemblance to sugar maple (*A. saccharum*), a dominant in the region's hardwood forests. This very shade-tolerant species has also become a major invasive of relatively undisturbed, mature deciduous forests of the northeastern US and adjacent Canada, where it is replacing the two overstory dominants, sugar maple and American beech (*Fagus grandifolia*) (Kloeppel and Abrams 1995, Wyckoff and Webb 1996, Anderson 1999, Webb *et al.* 2000). With its milky sap, Norway maple is presumably useless for maple syrup/sugar production. Thus this species poses a direct long-term threat to a very important cultural and economic resource of the upper Great Lakes region.

Another species of serious concern in pine barrens habitats is autumn-olive (*Elaeagnus umbellata*). Our survey found two small populations of this species, one well within the Moquah barrens. This species was (and occasionally still is) promoted for wildlife plantings and erosion control.

It has become a major pest on dry, infertile soils in parts of Ontario and the US (Sather and Eckardt 1987, Catling *et al.* 1997). Its seeds are widely distributed by birds. While not highly shade-tolerant, it is drought-tolerant and a nitrogen-fixer, and is able to displace native vegetation and alter natural communities. In addition to these two colonies, at least one other site for this species exists just west of the survey area, in northwest Bayfield county (WIS 2002).

While leafy spurge (*Euphorbia esula*) is still uncommon in the survey area, several colonies occur on private land just east of the Moquah barrens. A notorious invasive weed in the western US, it is a threat to open, mesic to dry habitats in the eastern US also (Bangsund *et al.* 1999, Czarapata 1999, Di'tomaso 2000). One population is quite large and dominates both sides of the road and an adjacent pasture. Except for goats and sheep, which favor the flower clusters, spurge is generally poisonous to domestic and wild grazers, reducing forage available to them (Olson and Wallander 1998, Czarapata 1999). Although its shade-tolerance is low, this species is extremely competitive and aggressive in mesic to dry open habitats, and presumably presents a significant threat to the open woods and other sandy habitats characteristic of the Moquah barrens.

Spotted knapweed is already widely established along roadsides and disturbed, dry areas throughout the survey area and the upper Great Lakes region (WIS 2002). Its shade-tolerance is low, precluding its spread into relatively undisturbed, closed-canopy forest. It has become a major weed of open pastures, grasslands, and rangeland over much of the western US, however (Harris and Cranston 1979, Roche and Roche 1991), and presumably presents a significant threat to the Moquah barrens. At least twelve insect species and one rust fungus have been released to combat spotted knapweed so far (Julien 1992, Weeden *et al.* 2002), several of which have been released (but have not necessarily become established) in the upper Midwest (Weeden *et al.* 2002). Spotted knapweed is a rare species in its indigenous range, apparently because of parasitism and predation by these organisms (Lang 2002).

Additional problem species

This survey revealed several relatively invasive species that, by their apparently aggressive behavior, have the potential to cause serious problems in the future. Some of these species are apparently still rare in the region and thus might be justified as targets for control or eradication from the region as a precautionary measure.

Woodland everlasting pea (*Lathyrus sylvestris*) proved to be abundant along highway corridors, logging roads, and woods edges along parts of the survey route, especially in eastern and northern Bayfield county. In these areas, this species was often the dominant along right-of ways (and in one case, a large "wildlife opening") for stretches of as much as several miles. By contrast, two cogeners, common everlasting pea (*L. latifolius*) and tuberous everlasting pea (*L. tuberosus*), often considered more invasive than *L. sylvestris*, were found in only a few sites. It is not clear at this point

how invasive and persistent *L. sylvestris* will prove to be in natural ecosystems, and what effects it will have on them, but its abundance in these habitats is cause for concern.

Due to its bird-distributed seeds, bittersweet nightshade (*Solanum dulcamara*) is widely established in the Upper Great Lakes region. Its habitat is usually low open woods and open or shaded wetlands, but it can survive and reproduce in dry upland sites as well (Pegtel 1985). Unripened berries are toxic to mice (and people) (Hornfeldt and Collins 1990). Due to its often low stature and ability to colonize forested or brushy areas, populations of this species are undoubtedly under-represented in the data.

Scotch pine (*Pinus sylvestris*) was not recorded at first, as it was assumed to be predominantly a plantation tree. After learning that it was a pest that freely re-seeded in parts of the Moquah barrens (Russ Newman, CNNF, pers. comm.), we began recording it. Most of the populations in the survey area appear to be discrete plantings, but seedlings and saplings are not infrequent, especially in older plantings (Steve Garske, pers. obs.). It is a species that should be monitored, and its planting should be discouraged.

Although not formally recorded during the survey, garden forget-me-not (*Myosotis sylvatica*) is widely established in more mesic road corridors, logging roads, and disturbed woods throughout the survey area. In western Upper Michigan it is locally abundant, invading relatively undisturbed, mature hardwood forests. Where it is found it often carpets the ground with its numerous deep blue flowers in the spring, and dying brown stems of spent plants by mid summer. In these areas it is often the most abundant plant on the forest floor by far in terms of numbers of individuals (or shoots), and perhaps in terms of biomass as well. Similar to *Alliaria petiolata* (garlic mustard), this species is a very shade-tolerant biennial or short-lived perennial. [Garlic mustard is an obligate biennial in North America (Anderson *et al.* 1996)]. Garden forget-me-not may one day turn out to be a major woodland pest.

One still-uncommon species (actually a species complex) includes brown knapweed (*Centaurea dubia*), black knapweed (*C. jacea*), and their fully-fertile hybrid, meadow knapweed (*C. jacea* × *C. nigra*, or *C.* × *pratensis*). These have collectively become established in several locations within the survey area along US Hwy 2. Additionally, a large population of *C.* × *pratensis* occurs along Hwy 2 just east of Wakefield, Michigan. Here, it is spreading into relatively undisturbed wet meadow (Steve Garske, pers. obs.). Roche and Roche (1991) consider these knapweeds (especially *C.* × *pratensis*) to be potentially serious invasives in the Pacific Northwest.

Another still-uncommon but potentially invasive species is blue buttons (*Knautia arvensis*). Blue buttons was found in relatively small but dense populations along roadsides in northern and central Bayfield county, as well as in open woods along the North Country National Scenic Trail in central Bayfield county.

Several Amur silvergrass (*Miscanthus sacchariflorus*) patches were found, most of which had obviously originated as plantings. One large population, on the southern edge of the Marengo city limits, appeared more or less "naturalized", however. This species has been shown to be cold-hardy in USDA hardiness zone 4a (Meyer *et al.* 1994).

One wild and one cultivated colony of wayfaring tree (*Viburnum lantana*) was found. Unlike most native *Viburnum* spp., which tend towards moist to wet habitats, wayfaring tree is a dryland species (Moor 1981), listed as an obligate upland species in Michigan by Herman *et al.* 2001. Along with a number of other invasive species, the US National Arboretum still promotes this species for landscaping, recommending it for dry sites in full sun (USNA 1999).

Yellow bedstraw (*Galium verum*) was found dominating an old homestead site as well as forming a smaller patch in partial shade, along the North Country Trail. German catchfly (*Lychnis viscaria*), which is apparently known in Wisconsin from only one northeastern Bayfield county site (WIS 2002), appears to be spreading rapidly into pasture and open woods there.

A number of seemingly less aggressive invasives are also established in the region. These include nipplewort (*Lapsana communis*), common speedwell (*Veronica officinalis*), and sweet vernal grass (*Anthoxanthum odoratum*), which appear to be moving into the region from the south and east. Common speedwell is well-established in hardwood forests of western Upper Michigan, forming patches of up to a meter or so across, and often appearing as a native there (Steve Garske, pers. obs.). While its low stature and lack of large showy flowers surely resulted in its being under-recorded, it appeared to be fairly frequent in the eastern part of the survey area and uncommon to rare in the western part. Other species of concern in the surveyed area include bell flower (*Campanula rotundifolia)*, soapwort (*Saponaria officinalis)*, black locust (*Robinia pseudoacacia*), and goutweed (*Aegopodium podagraria*).

Although not found during our survey, one other invasive is poised to become a serious problem in the Upper Great Lakes Region. Eurasian marsh thistle (*Cirsium palustre*) is a large (to 2 m or more), very spiny monocarpic perennial that is well-established throughout most of Upper Michigan, and has spread into adjacent lower Michigan and northeastern Wisconsin (Voss 1996, WIS 2002). Voss (1996, p. 519) briefly describes marsh thistle's introduction and spread in Michigan. It continues to spread rapidly westward and southward. British Columbia has issued an invasive plant "Alert Notice" for this species (Martin 2001). It is somewhat shade tolerant, and can apparently invade and displace native vegetation in a wide variety of damp to wet habitats, from roadside ditches to open wet woods and wetlands (Voss 1996, Martin 2001).

Summary

In general, there appears to be a strong tendency for species used as landscape plantings to

become established just outside of cities, towns, and other areas of settlement, decreasing in abundance with distance from these areas (Figure 7). These species appear to be following roads, trails, power and gas corridors, and other disturbed areas away from plantings and other points of introduction. By contrast, except for the occasional presence of one or more of the "ubiquitous" species mentioned above (Table 2), relatively undisturbed forests and other habitats in and around the CNNF appear to be mostly free of invasive species. Thus there is still an opportunity to implement carefully-planned control measures against some of these species.

GLIFWC is currently compiling a comprehensive invasive plant database that will facilitate prioritization of invasive plant species for management purposes based on the following general criteria: (1) current ecological impacts, (2) potential ecological impacts, and (3) feasibility of control. The field data and observations collected during this survey will be included in the database to help gauge current ecological impacts based on species composition, relative abundance, and affected habitats in the survey area.

INVASIVE PLANT EDUCATIONAL OUTREACH ACTIVITIES

INTRODUCTION

Because the vast majority of invasive plant introductions are attributable to human activities, effective prevention and control efforts depend on an informed public. Unfortunately, awareness of the ecological and economic impacts of invasive plants among the general public is generally low (Colton and Alpert 1998). To help address this situation, GLIFWC initiated an educational outreach program in 1998 to raise public awareness of this important issue.

PROGRAM OVERVIEW

A suite of educational materials, with an emphasis on purple loosestrife, have been compiled and/or developed to reach a broad range of audiences. These materials include brochures, slide and poster presentations, and videos. Additional outreach is provided via the *Exotic Plant Information Center* web site (www.glifwc.org/epicenter), newspaper articles, and presentations at local events. In 2001, emphasis was placed on upgrading the web site to include additional invasive species and provide a "clearinghouse" for information on invasive plants in the upper Great Lakes region.

ACCOMPLISHMENTS

In 2001, GLIFWC distributed 1,200 *Purple Loosestrife: What You Should Know, What You Can Do* brochures and 5,200 *Plants Out of Place* brochures to cooperating agencies, non-government organizations, and private citizens. Several articles were also written or contributed to GLIFWC's newsletter *Mazina'igan*, the *Ashland Daily Press*, and the *ANS Update* (Newsletter of the Great Lakes Panel on Aquatic Nuisance Species). GLIFWC's purple loosestrife program was also featured on the nationally televised program *The Cutting Edge of Technology Report: Plants out of Place (Exotic Weeds)*, produced by the Information Television Network. The program debuted in Washington D.C. during "National Invasive Weeds Awareness Week" in March, 2001.

A comprehensive web site devoted to purple loosestrife was initially published on GLIFWC's web site in 1999. In 2001, a series of java-scripted templates were developed to standardize the look of the site, and improve site navigation. The web site was also reorganized into 9 sections (Table 4). Although still under construction, the new templates and organization provide a foundation that makes it much easier to add and update information. Species accounts were added for buckthorn, honeysuckle, leafy spurge, and garlic mustard. Photographs, distribution data, and other information obtained during the invasive plant survey will be added to the site in 2002.

Table 4. Organization and status of GLIFWC exotic plant web site.

Section	Description	Status
Species Accounts	Information on ID, ecology, impacts, and control	6 spp. online
Internet Map Server	Interactive maps depicting distribution and control efforts	loosestrife data online
Literature Search	Searchable database of literature citations	under construction
GLIFWC Reports	GLIFWC's annual invasive plant reports in PDF format	online
Slide Library	Searchable database of images available for educational uses	online
Educational Materials	Links & contacts for obtaining educational materials	online
Internet Resources	Links to other invasive plant web sites	online
Funding	Information on grants funding invasive plant activities	under construction
Site Map	Aids navigation within the web site	online

REMAINING NEEDS

Information on non-native invasive plants is widely scattered. In 2002, GLIFWC will place an emphasis on using the web site as a means of coordinating and consolidating this information to provide a comprehensive portal for anyone seeking information on invasive plants in the upper Great Lakes region.

INTERAGENCY COORDINATION

INTRODUCTION

Because non-native invasive plants disperse widely across the landscape and administrative boundaries, it is advantageous to work cooperatively towards management and control objectives. In addition, the number of new exotics being introduced into local ecosystems continues to out-pace control activities, and is too much for any one agency to manage alone.

ACTIVITIES

To address this need, GLIFWC has undertaken several activities designed to enhance cooperation and coordination among government agencies, non-government organizations, and private citizens (Table 5).

Table 5. Cooperative activities conducted in 2001.

Cooperators	2001 GLIFWC Activities
Keweenaw Bay Indian Community (KBIC)	Provided ~8,000 *Galerucella* beetles for control of purple loosestrife.
Northwoods Weed Initiative (NWI)	Developed a poster highlighting NWI activities for the *Plants out of Place* Conference in March, 2001.
Invasive Plant Association of Wisconsin (IPAW)	Consulted with IPAW's Science Committee to design and implement a survey to solicit data on invasive plants from professionals in the field.
The Nature Conservancy (TNC)	Coordinated purple loosestrife control efforts in the Bad River - Chequamegon Bay watershed.
Wisconsin Dept. of Natural Resources (WIDNR)	Participated on WIDNR's Invasive Species Team to provide technical advice to the Governor's Task Force on Invasive Species.
U.S. Forest Service (USFS)	Compiled USFS invasive plant distribution data with GLIFWC data for future Internet map services.
Other cooperating agencies	Provided educational brochures to numerous cooperators.
Internet users	Upgraded *Exotic Plant Information Center* web site and Internet map server software and content.

FUTURE WORK

In 2002, GLIFWC will continue to provide *Galerucella* beetles and other technical assistance to GLIFWC member tribes requesting those services. Additional activities will include assisting the Wisconsin DNR develop a statewide Aquatic Nuisance Species Management Plan that accommodates Tribal concerns, consulting with IPAW's education committee and the UW Extension to identify cooperative projects that increase public awareness of invasive species issues.

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GL 005572-01

Invasive Non-native Plant Management During 2002

by

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Administrative Report 02-12
February 10, 2003

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EXECUTIVE SUMMARY

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an organization exercising delegated authority from 11 federally recognized Ojibwe tribes in Minnesota, Wisconsin, and Michigan (Figure 1). These tribes retain hunting, fishing, and gathering rights in the territories ceded to the United States through various treaties (Figure 1). The exercise of these rights may be threatened by the degradation of native ecosystems by invasive non-native plants.

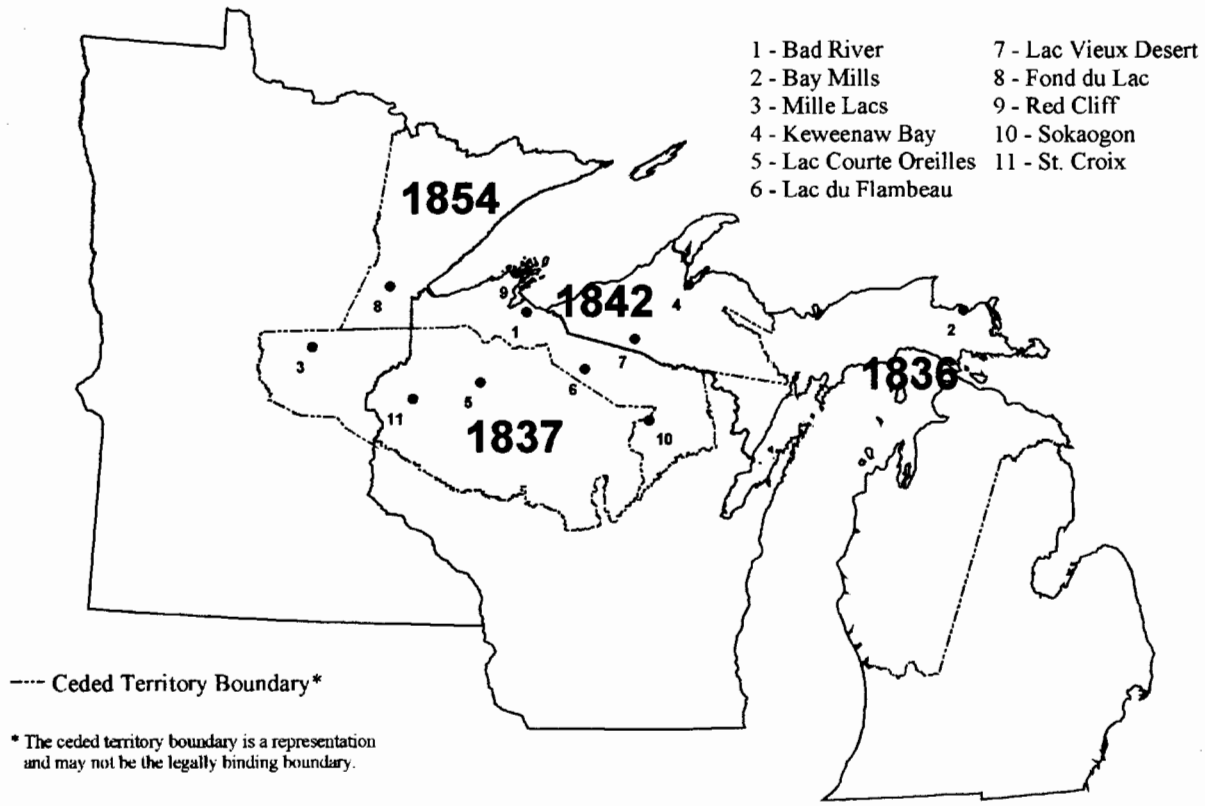


Figure 1. Location of GLIFWC member tribes and ceded territories.

Invasive species are considered by many biologists to be the second most important cause of biodiversity loss and species extinction worldwide, ranking only behind habitat destruction (OTA 1993, Wilcove *et al.* 1998, Enserink 1999). Wilcove *et al.* (1998) estimated that 57% of plants on the endangered species list are there at least in part because of non-native invasive species. Besides physical displacement of native flora and fauna, non-native plants can alter fire frequency, hydrologic properties, soil chemistry, and the physical structure of ecosystems (Walker and Smith 1997,

Westbrooks 1998). This report summarizes the activities undertaken by GLIFWC staff during 2002 to address the spread of invasive non-native plant species in the ceded territories. In 2002, GLIFWC staff identified the need to 1) continue chemical and biological control of purple loosestrife, and 2) developed objective prioritization criteria to guide future management of non-native invasive plants in the ceded territories.

GLIFWC staff have conducted several inventories and annual control work on purple loosestrife (*Lythrum salicaria*) since 1988 (Gilbert and Parisien 1989, Edblom et al. 1995, Gilbert *et al.* 1995, Gilbert et al. 1998, Falck et al. 1999, Falck *et al.* 2000). GLIFWC and The Nature Conservancy (TNC) crews treated almost twice as many loosestrife patches in 2002 compared to 2001. The use of biological controls at the larger loosestrife sites has allowed control crews to focus on small satellite populations that are easier to eradicate with herbicide. In 2002, a reduction in loosestrife flowering was apparent at several of the large loosestrife stands where biological controls were released in 2000 and 2001. Also in 2002, biological control efforts were extended to areas outside of the Bad River - Chequamegon Bay watershed

To address the threats posed by other non-native plants found within the ceded territories, a database was compiled to help guide and prioritize future management. A prioritized list of non-native plants was developed for the entire ceded territories, organizing species into four categories of management based on their ecological impacts and feasibility of control. Local abundance data (Falck and Garske 2002) were used to generate a prioritized list for Ashland and Bayfield counties. The database should be useful throughout the Upper Great Lakes region for similar applications, especially when used with local abundance data.

ACKNOWLEDGMENTS

The activities summarized in this report were partially funded by the Bureau of Indian Affairs' Noxious Weed Program (BIA), the Environmental Protection Agency's Great Lakes National Program Office (EPA-GLNPO), the Natural Resources Conservation Service's Environmental Quality Incentive Program (NRCS-EQIP), and TNC.

PURPLE LOOSESTRIFE CONTROL ACTIVITIES IN THE BAD RIVER-CHEQUAMEGON BAY WATERSHED

INTRODUCTION

Purple loosestrife is a perennial, herbaceous wetland plant native to Europe. It arrived in eastern North America in the early 1800's via plants brought by settlers and seeds carried within livestock and the ballast holds of ships (Thompson *et al.* 1987). In North America, purple loosestrife quickly spread westward displacing native wetland plant communities. Its current distribution covers much of the U.S. and Canada. GLIFWC has been treating purple loosestrife within the Bad River - Chequamegon Bay watershed since 1988. The Nature Conservancy (TNC) has been contributing to this effort in cooperation with GLIFWC since 1998 with an emphasis on private lands in the upper reaches of the watershed.

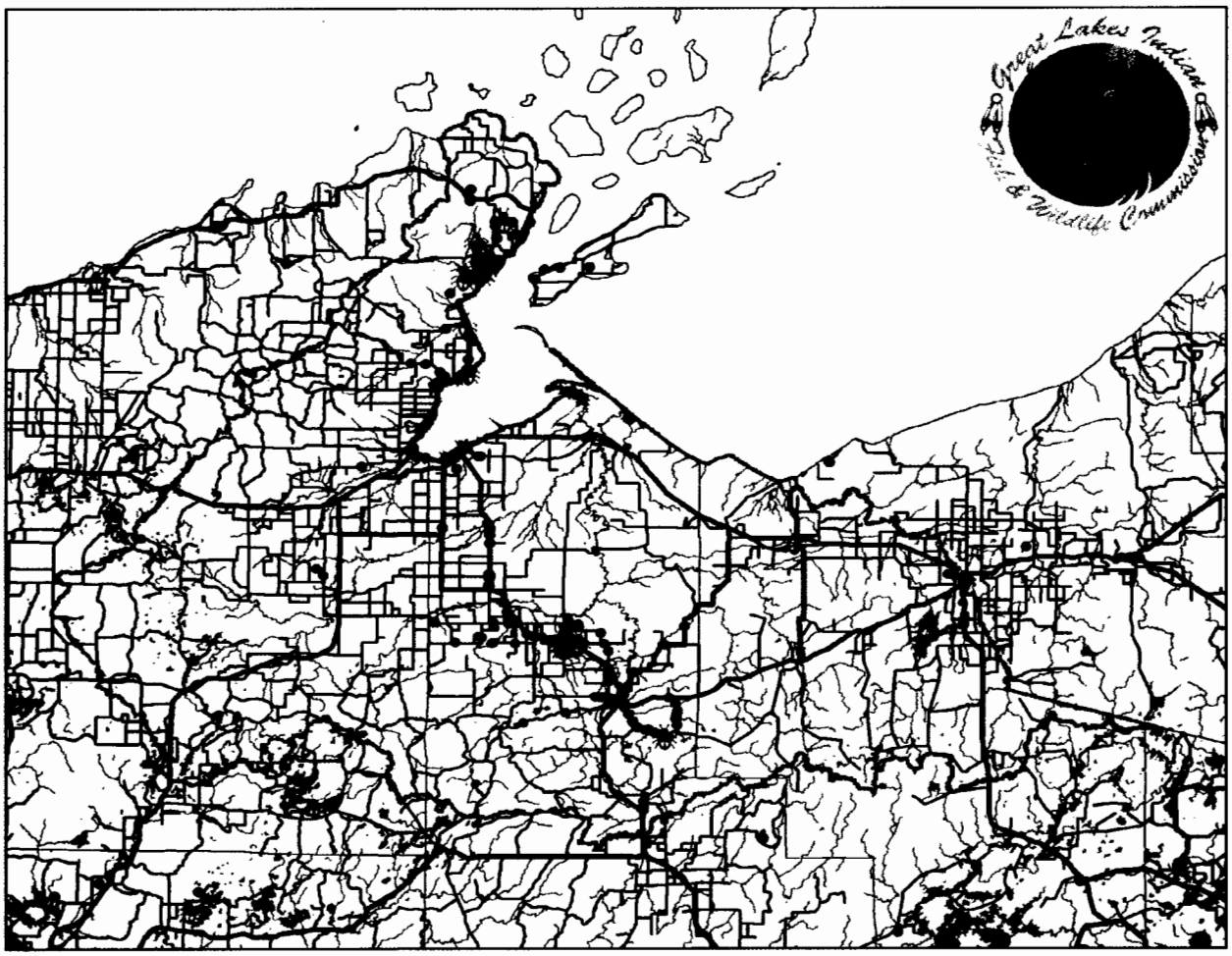
METHODS

Purple loosestrife populations within the Bad River - Chequamegon Bay watershed were inventoried in 1994, 1995, 1999, and 2000 (Gilbert *et al.* 1995, Edblom *et al.* 1995, Falck *et al.* 2000, Falck 2001). Data from these surveys were used to prioritize effort and select control methods based on the area of the site, number of plants, and the site's location within the watershed. Small sites with few plants (< 1 acre or < 1,000 plants) that threatened to infest downstream reaches were given the highest priority for chemical control (Figure 2). Large sites (> 1 acre or > 1,000 plants) were given low priority for chemical control but high priority for biological control (Figure 2).

Chemical Control

Prior to conducting field applications of herbicide, all loosestrife control workers attended a 1-day training workshop conducted by GLIFWC staff. Participants learned or reviewed safe handling, storage, and application procedures, applicable state and federal regulations, and received training on equipment operation and maintenance.

Herbicides were applied to loosestrife stands using backpack sprayers. Glyphosate, a non-selective herbicide, was used in very dense stands or over water. The dicot-specific herbicide triclopyr was used on dry sites such as roadsides and fields. Efforts were focused primarily on the Fish Creek Slough, and the Highway 13 right-of-way between Highbridge and Washburn. Private uplands in the Highbridge area were treated primarily by staff from TNC with assistance from the GLIFWC crew, after consent forms were signed by the landowner.



Control Priority/Method

- High/Biological
- High/Chemical
- Low/Chemical

- Focus Watershed
- Primary Roads
- Secondary Roads
- Rivers
- Lakes

N

0 5 10 20 Miles

Overview:

Figure 2. Control priority and method for off-reservation purple loosestrife sites, 2002.

Biological Control

The release of *Galerucella* beetles (native to Europe) in the United States for biological control of purple loosestrife was approved by USDA - APHIS in 1992. *Galerucella* beetles were reared following methods outlined by Loos and Ragsdale (1998). Mature purple loosestrife root stock was transplanted into pots from a population on Wisconsin DNR property, at the mouth of the Sioux River. The UW-Extension's Ashland Agricultural Research Station provided space for rearing *Galerucella* beetles. One hundred sixty potted plants were placed in small wading pools containing 4-6 inches of water. In late May and early June, adult *Galerucella* beetles were collected from previous release sites and placed on the potted plants. Approximately 10-12 beetles were placed on each plant, which were enclosed in individual mesh net bags to protect the beetles and their larvae from bird and insect predation. An estimated 750 adult beetles (Brock Woods, WI DNR, pers. comm.) were reared in each pot.

Evaluation

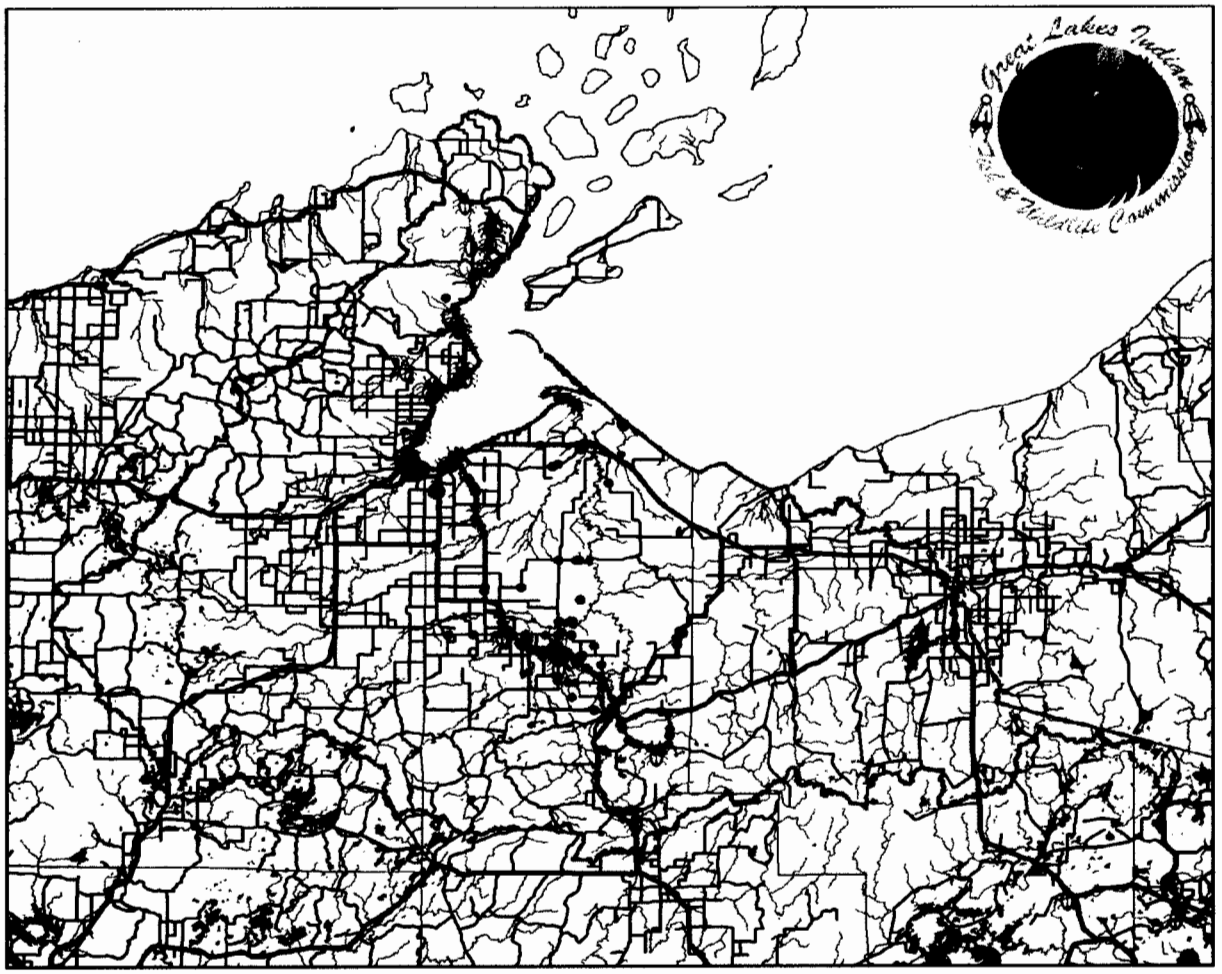
The location of each treated loosestrife patch was mapped using GPS and coded by control method to quantify the progress of control efforts in 2002. All *Galerucella* release sites were photographed during the peak of purple loosestrife's blooming period to document the pre- and post-treatment conditions at each site.

RESULTS

A total of 193 sites were treated in 2002. GLIFWC crews released approximately 225,000 *Galerucella* beetles among 20 sites and treated another 119 sites with herbicide, while TNC crews applied herbicide at 54 additional sites (Figure 3). The success of biological control was evaluated at 25 sites where beetles were released in 2000 and 2001. *Galerucella* beetles successfully overwintered at all 25 sites, and a reduction in loosestrife flowering was visually apparent at several sites (Figures 4-6).

DISCUSSION

The use of biological controls has expanded the acreage treated annually by GLIFWC's purple loosestrife control program and allowed control crews to place more emphasis on treating small satellite populations with herbicide before they become significant source populations. Increased production of *Galerucella* beetles in 2002 enabled GLIFWC to expand control efforts beyond the Bad River - Chequamegon Bay watershed for the first time since control efforts were initiated in 1988 (Figure 3).



GLIFWC Biocontrol Efforts:

- *Galerucella* Release Site 2002
- *Galerucella* Release Sites 2000 - 2001

Chemical Control Efforts by Organization:

- GLIFWC
- TNC
- Focus Watershed
- Primary Roads
- Secondary Roads
- Rivers
- Lakes

N

0 5 10 20 Miles

Overview:

Figure 3. Purple loosestrife control activities in the Bad River-Chequamgeon Bay watershed, 2002.

Figure 4. Comparison of purple loosestrife flowering in 2001 vs. 2002 at Washburn site following release of *Galerucella* beetles in July, 2001.

Figure 5. Comparison of purple loosestrife flowering in 2001 vs. 2002 near Whittlesey Creek following release of *Galerucella* beetles in July, 2000.

Figure 6. Comparison of purple loosestrife flowering in 2000 vs. 2002 at Bayfield Apple Company following release of *Galerucella* beetles in July, 2000.

PRIORITIZATION OF NON-NATIVE INVASIVE PLANTS

INTRODUCTION

GLIFWC has achieved some success in controlling purple loosestrife (Falck 2001). Unfortunately, within the ceded territories, there are several hundred additional non-native plants that vary in their impact to natural ecosystems and feasibility of control. In 1999, GLIFWC staff recognized the need to develop a database for invasive plants that could be used to help guide future management efforts. Specifically, the database could be used to prioritize species for management, target educational outreach, and identify threats to treaty resources.

Because agency resources are limited, management efforts must be prioritized. This report summarizes GLIFWC's effort to compile a database of non-native plants and develop a list that ranks each species from a consistent set of ecological criteria and methods. Although similar lists have been developed previously for regions within the ceded territories, it was not always clear how they were derived. GLIFWC's approach was adapted conceptually from the *Alien Plant Ranking System* (APRS) (Hiebert and Stubbendieck 1993) and sought to prioritize those species that posed the greatest threats to local ecosystems and had the greatest likelihood for successful control.

METHODS

Conceptual Overview

The general process and criteria used to prioritize and categorize each species is outlined in Figure 7. Initially, a pool of potentially invasive non-native plants was compiled from lists developed by Region 9 of the US Forest Service, two of the states encompassing the ceded territories, and field data collected in 2001 (Falck and Garske 2002). Those species considered incapable of surviving the winter in the ceded territories were then removed from further consideration. The remaining species were categorized into seven general habitats based on their tolerance for shade and their wetness coefficients (Figure 8). Species with no known occurrence in the ceded territories were assigned a "watch value" (*W*) of "1", while species that were already present in the ceded territories received a watch value of "0".

All species were then prioritized based on criteria that indicated: 1) the level of impact (*LOI*), 2) the feasibility of control (*FOC*), and 3) whether or not they are present in the ceded territories (*W*). Each criteria was evaluated or scaled to a numerical range of 0-1 to give them each equal weight. Low values represented little ecological impact or easy control, while high values represented substantial ecological impact or difficult control. A cumulative value for *LOI* and *FOC* was calculated by averaging the relevant criteria for each species. Finally, management priority (*MP*) was calculated by subtracting *FOC* from *LOI* and adding *W* to weight recent introductions. Based on the resulting priority values, species were assigned to one of four management categories similar to Olliff *et al.* (2001) by habitat.

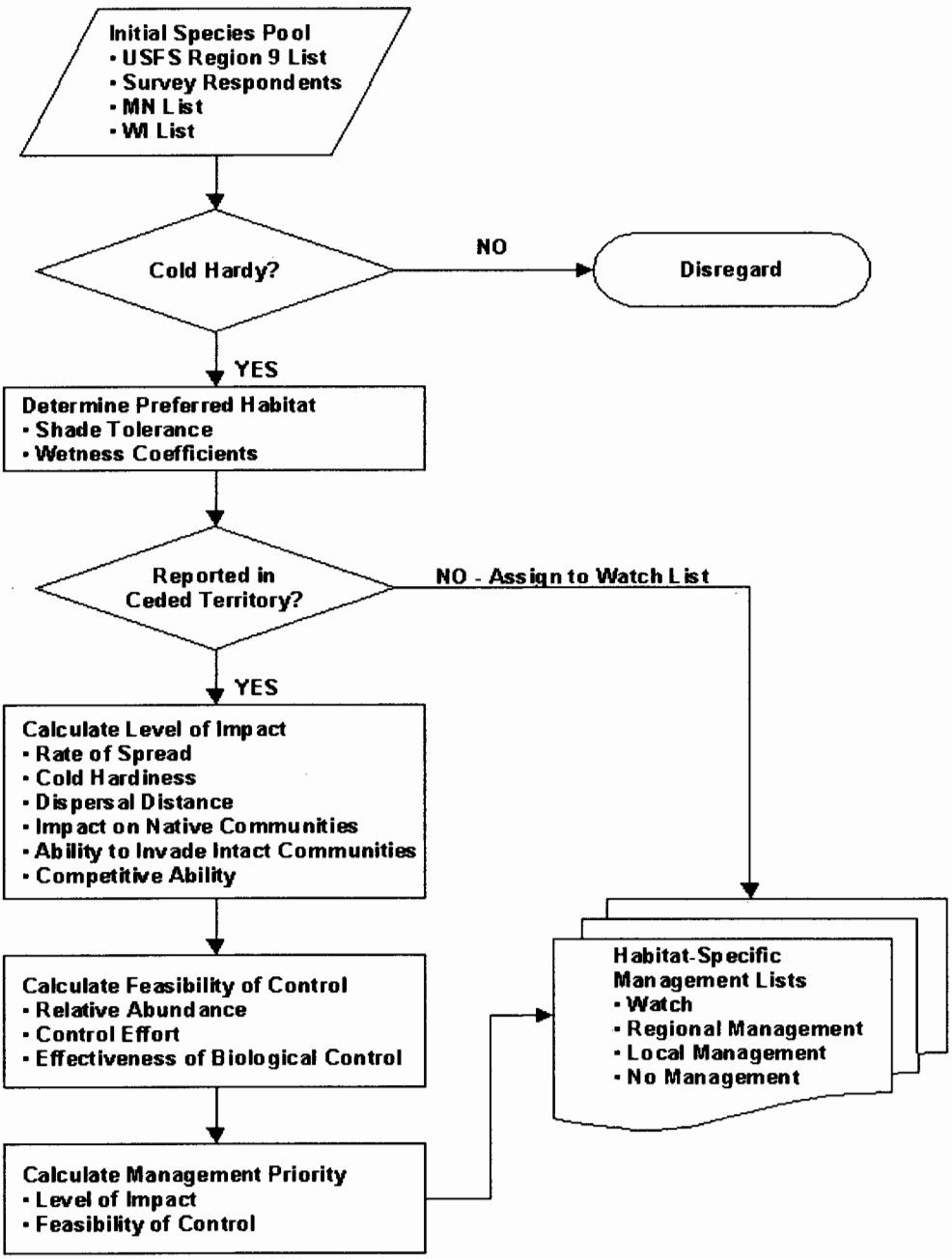


Figure 7. General process and criteria used to prioritize non-native plants.

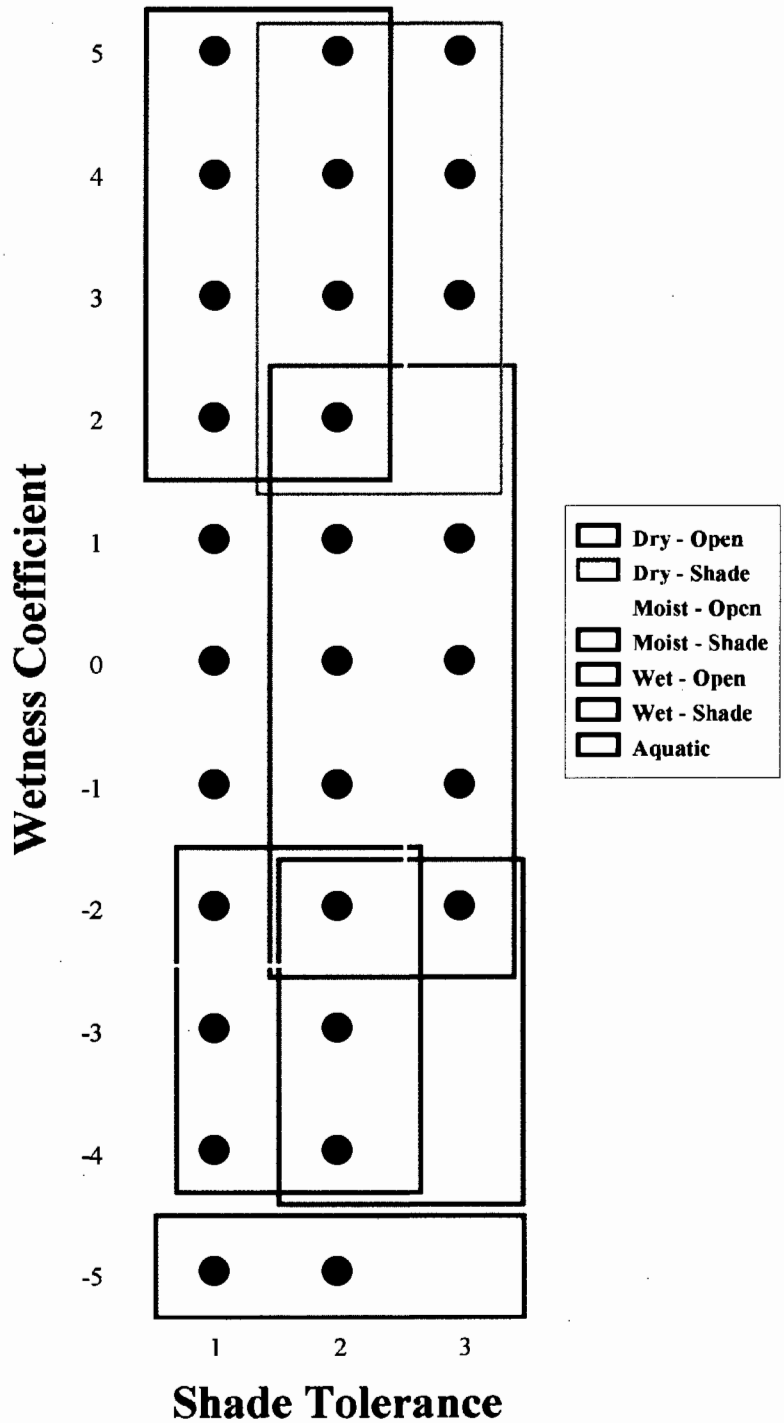


Figure 8. Habitat delineations for non-native plants based on wetness coefficients and shade tolerance.

Data Sources

In an effort to maximize the consistency of data used, the more comprehensive sources of information available for each criteria were sought. However, no source covered every species on the list (Table 1 summarizes the prioritization criteria used, the data sources they were derived from, and the computations used to prioritize the list).

Because published and online data sources lacked information on many of the criteria being used, additional data were developed through a survey (Appendix A) designed in cooperation with the Invasive Plant Association of Wisconsin (IPAW). This survey was mailed to botanists and land mangers throughout Minnesota, Wisconsin, and Michigan. Participants were instructed to provide answers for only those species they had direct experience with. They were also encouraged to add species they perceived as invasive, but were not included on the list. The survey asked participants to rank individual species from the initial pool for their: 1) ability to invade undisturbed habitats, 2) relative abundance, 3) impact on native communities, 4) competitive ability, 5) observed rate of spread, and 6) feasibility of effective control. For each question, a mean response was calculated for each species. Each question was standardized to a scale of 0-1 by dividing the mean for each species by the highest mean calculated for that question. Survey participants were also asked to note the ecoregion(s) (McNab and Avers 1994) where they had observed each species. Only responses from ecoregions partially or entirely within the ceded territories were used in the analysis.

Initial Species Pool

All species listed on the US Forest Service's *Invasive plants reported within the Eastern Region* (USFS 2001) comprised our initial list. Species designated as "state noxious", "restricted noxious", or "prohibited exotic species" by the State of Minnesota (Baumann *et al.* 2000), and "ecologically invasive" by the Wisconsin State Herbarium (WIS 2002) were included as well. Several non-native species that were observed to be abundant and reproducing in natural habitats by GLIFWC staff, or that were suggested by GLIFWC/IPAW survey respondents were also added to the list. Species that were native to at least one state within the ceded territory (*e.g. Rhus typhina, R. glabra*) were removed from the list, while species not native to any of the three states were retained.

Habitat Preferences

Species were assigned to seven general habitat types based on reported shade tolerance and wetland coefficients (Figure 8). Shade tolerance values were derived primarily from Grime *et al.* (1988), Bown (1995), Brickell and Zuk (1997), and USDA-NRCS (2002). Where data were unavailable, values were assigned based on field observations and experience. Shade tolerance values ranged from 1 (intolerant) to 3 (tolerant of deep shade).

Wetness coefficients were primarily obtained from Herman *et al.* (2001). For species not provided in Herman *et al.* (2001), coefficients were taken directly from the *1996 national list of*

Table 1. Data sources, computations, and criteria used to prioritize invasive species.

Prioritization Components and Criteria	Notation	Formula	Data Source(s)
Initial Species Pool			GLIFWC-IPAW survey, Baumann *et al.* (2000) (regulatory classification = "state noxious" or "restricted noxious" or "prohibited exotic species"), USFS (2001), WIS (2002) (status = "ecologically invasive")
Habitat Preference			
Shade tolerance			Grime *et al.* (1988), Tenenbaum *et al.* (1994), Bown (1995), Brickell and Zuk (1997), USDA-NRCS (2002)
Wetness coefficient			Grime *et al.* (1988), Gleason and Cronquist (1991), USFWS (1996), Herman *et al.* (2001)
Level of Impact	*LOI*	$(ORS + VSR + CH + PDD + ATI + INC + CA)/7$	
Cold Hardiness	*CH*	see text	Tenenbaum *et al.* (1994), Bown (1995), Brickell and Zuk (1997), USNA (2001), USDA-NRCS (2002)
Ability to invade undisturbed habitats	*ATI*	$\bar{\chi}(survey\ response)$	GLIFWC-IPAW survey
Impact on native communities	*INC*	$\bar{\chi}(survey\ response)$	GLIFWC-IPAW survey
Competitive ability	*CA*	$\bar{\chi}(survey\ response)$	GLIFWC-IPAW survey
Observed rate of spread	*ORS*	$\bar{\chi}(survey\ response)$	GLIFWC-IPAW survey
Vegetative spread rate	*VSR*	see text	Voss (1972-1996), Gleason and Cronquist (1991), USDA-NRCS (2002)
Potential dispersal distance	*PDD*	see text	Voss (1972-1996), Grime *et al.* (1988), Gleason and Cronquist (1991), Cronk and Fuller (1995), Uva *et al.* (1997), Holmgren (1998), USDA-NRCS (2002)

Table 1. (continued)

Prioritization Components and Criteria	Notation	Formula	Data Source(s)
Feasibility of Control	*FOC*	$(EOB + CE + RAx)/3$	
Relative abundance			
Local	*RAl*	% occurrence of total sites inventoried	Falck and Garske (2002)
Regional	*RAr*	% counties of occurrence in ceded counties	Voss (1972-1996), MINN (2002), WIS (2002)
Effectiveness of biological control	*EOB*	see text	Julien (1992), Cronk and Fuller (1995), Deloach (1997)
Control effort	*CE*	$\overline{\chi}$ (*survey response*)	GLIFWC-IPAW survey
Watch	*W*	if $RAx = 0$, $W = 1$ if $RAx > 0$, $W = 0$	
Management Priority	*MP*	$(LOI - FOC) + W$	
Management Category 1		$W = 1$	
Management Category 2		$W = 0$; $MP > 75^{th}$ percentile	
Management Category 3		$W = 0$; 75^{th} percentile $> MP > 50^{th}$ percentile	
Management Category 4		$W = 0$; $MP < 50^{th}$ percentile	

vascular plant species that occur in wetlands (USFWS 1996), using values for the North Central Region or, when those were not available, the Northeastern Region. Both Herman *et al.* (2001) and USFWS (1996) derived most of their coefficients from the *National wetland indicator categories* of Reed (1988). For plants where data were unavailable from these sources (<10%), rankings given for other regions by USFWS (1996) were used, as well as information given in Grime *et al.* (1988) and Gleason and Cronquist (1991). Wetness coefficients ranged from -5 (obligate aquatic) to 5 (obligate upland).

Level of Impact (*LOI*)

An index to level of impact for each species was determined by averaging the following seven criteria:

Cold Hardiness (*CH*). Information on cold-hardiness was compiled primarily from the USDA - PLANTS database (USDA-NRCS 2002) and published horticultural sources (Tenenbaum *et al.* 1994, Bown 1995, Brickell and Zuk 1997, MBG 2002). The USDA-NRCS (2002) data for minimum cold-tolerance temperatures were considered the most reliable and were converted to hardiness zones using the US National Arboretum's hardiness map and table (USNA 2001). Where USDA-NRCS (2002) data were unavailable, the lowest zone (hardiest) reported by the other sources was used. For those species for which cold tolerance data could not be found, or where existing data was obviously in error, a zone was assigned by comparing its known distribution to the US National Arboretum's hardiness map (USNA 2001).

Based on its assigned minimum hardiness zone rating, each species was assigned to one of three categories, reflecting its ability to survive winter in the ceded territories. A "1" was assigned to species considered cold-hardy to zone 4 or less, "2/3" was assigned to species hardy to zone 5, and "1/3" was assigned to species hardy only to zone 6. Species hardy only to zone 7 or higher were removed from further consideration. Because annuals from warmer climates are likely to survive the winter as seeds, they were assigned "1".

Ability to Invade Undisturbed Habitats (*ATI*). Survey participants were asked to report the disturbance history of sites where they had observed each species (Appendix A). A mean response was calculated for each species, and the means were scaled to a range of 0 (high disturbance sites) to 1 (low disturbance sites). The categories included: 1) disturbed within last 3 years, 2) disturbed within last 10 years, 3) disturbed 11-50 years before present (BP), 4) disturbed 51-100 years BP, and 5) disturbed >100 years BP.

Impact on Native Communities (*INC*). Survey participants were asked to assign each species to one of three categories (Appendix A). A mean response was calculated for each species,

and the means were scaled to a range of 0 (little impact) to 1 (high impact). The categories included: 1) has little or no ecological impact, 2) invades and modifies native communities, or 3) invades and replaces native communities.

Competitive Ability (*CA*). Survey participants were asked to rate each species' competitive ability (Appendix A). A mean response was calculated for each species, and the means were scaled to a range of 0 (poor) to 1 (high). The categories included: 1) poor, 2) moderate, or 3) high.

Observed Rate of Spread (*ORS*). Survey participants were asked to rank the rate of spread by assessing the change in abundance over the past five years for each species (Appendix A). A mean response was calculated for each species, and the means were scaled to a range of 0 (decreased) to 1 (more than doubled). The categories included: 1) decreased, 2) remained the same, 3) increased slightly, and 4) more than doubled.

Vegetative Spread Rate (*VSR*). The vegetative spread rate was assessed based on growth forms reported in individual species descriptions [primarily in Gleason and Cronquist (1991), Voss (1972-1996) , and USDA-NRCS (2002)]. Annuals were assigned "1/3", perennials that do not spread significantly by stolons or rhizomes were assigned "2/3", and perennials that do spread significantly by stolons or rhizomes were assigned "1".

Potential Dispersal Distance (*PDD*). Potential dispersal distance was assessed using the classification system of Grime *et al.* (1988). For species not listed by Grime *et al.* (1988), information from other sources (Voss 1972-1996, Gleason and Cronquist 1991, Cronk and Fuller 1995, Uva *et al.* 1997, Holmgren 1998, USDA-NRCS 2002) was used to classify propagule adaptations. Plants spreading primarily vegetatively, or by small seeds disseminated from elevated capsules, or those adapted for dispersal by ants were considered the least mobile and assigned a value of "1/3". Propagules having no obvious dispersal adaptations, or adhering to animals via sticky substances were assigned a value of "2/3". Propagules adapted for aquatic dispersal, wind dispersal (*e.g.* winged, plumed, and minute seeds), animal attachment via hook-like structures (*e.g.* burs and awns), or ingestion by animals were considered the most mobile by natural means and were assigned a value of "1".

Feasibility of Control (*FOC*)

An index to feasibility of control for each species was determined by averaging the following three criteria:

Relative Abundance (*RA*). Information from herbarium records [MINN (2002),WIS (2002) and Voss (1972-1996)] were used to assess regional abundance (*RAr*). The percent of counties within

the ceded territories that each species was reported from was used to quantify regional abundance. Local abundance (*RAI*) for each species was assessed from field data collected by Falck and Garske (2002). Field data collected in 2001 (Falck and Garske 2002) were quantified as a percentage of total non-native plant populations recorded for each species. Species that were too widespread and abundant to map efficiently (Falck and Garske 2002, Table 4) were assigned "1".

Effectiveness of Biological Control (*EOB*). The effectiveness of biological control for each species was evaluated by the number of "effective" or "somewhat effective" biological controls reported in the literature [primarily from Julien (1992)]. This criteria was transformed to a scale of 0-1 by dividing the number of effective biological controls by the maximum number reported for a single species. The resulting scale was reversed so that the species with the most effective biological controls had a value of "0" and species with no biological control had a value of "1".

Control Effort (*CE*).Survey participants were asked to assign each species to one of five control categories (Appendix A). A mean response was calculated for each species, and the means were scaled to a range of 0 (none required) to 1 (not feasible). The categories included: 1) none required, susceptible to natural succession, 2) one-time management application, 3) periodic management required, 4) requires annual management, and 5) no feasible control option.

Management Priority (*MP*)

A management priority index was calculated using the following formula: $(LOI - FOC) + W$. Each species was assigned to one of the following four management categories based on its *MP* value:

Category 1. Category 1 consisted of species not yet detected within the ceded territories (W=1) but known to cause substantial impacts in similar habitats elsewhere in North America. These species should be controlled immediately upon detection, before they become established and spread. Early detection and treatment of new invasives before they spread is by far the most efficient and effective way to prevent new invasions and the problems they will cause (Hobbs and Humphries 1995, Moody and Mack 1988).

Category 2. Category 2 consisted of species that cause severe ecological impacts and/or occur in a few small populations and/or have a wide array of effective control options available. These species have the greatest potential for being controlled cost effectively using integrated pest management techniques. Species with $MP > 75^{th}$ percentile (excluding species with $W = 1$) were assigned to this category. All other things being equal, control of invading plant populations is much more effective if small satellite populations are destroyed than if large infestations are treated and small populations are left to expand (Moody and Mack 1988).

Category 3. Category 3 consisted of species that cause moderate to severe ecological impacts and/or occur in several established populations and/or have limited effective control options available. These species may be managed cost effectively on a smaller scale in ecologically or culturally sensitive areas (*e.g.* small natural areas) using integrated pest management techniques. Species with 75th percentile > MP > 50th percentile (excluding species with $W = 1$) were assigned to this category.

Category 4. Category 4 consisted of species that cause low to moderate ecological impacts and/or have widespread established populations and/or have limited effective control options. These species have little potential for successful management in the absence of biological control. Species with MP < 50th percentile (excluding species with $W = 1$) were assigned to this category.

RESULTS AND DISCUSSION

The process described above resulted in an initial pool of 330 potentially invasive non-native plants for the ceded territory. Of these, five were removed from consideration because they were considered incapable of surviving the winter in the ceded territories. Table 7 summarizes the number of species in each management category by habitat. A composite list for all habitats as well as habitat-specific lists sorted by descending management priority are provided in Appendices B-I.

Table 2. Number of species in each management category by habitat.

Habitat	Management Category				Total
	1	2	3	4	
Dry - open	42	34	41	86	203
Dry - shade	31	22	21	24	98
Moist - open	7	2	5	25	39
Moist - shade	8	5	4	9	26
Wet - open	8	5	6	7	26
Wet - shade	6	5	5	5	21
Aquatic	14	7	2	2	25
All	90	58	60	117	325

The primary source of uncertainty in this method was incomplete data for individual species. For example, specific information on ecological impacts was available for only a few species. Consequently, survey participants were relied on to assign values for many of the ecological impact criteria.

A total of 179 individual species responses to the GLIFWC/IPAW survey were returned. The number of responses received for each species ranged from 1-19. Values from the 39 species with only 1 response were not used in the priority computations. The mean number of responses for the 140 species with > 1 response was 5.75. Of the 146 species that received < 2 responses, 77 were assigned

to management category 1 based on distribution data. A total of 66 species were assigned to management categories 2 - 4 based solely on the data compiled from published sources and online databases (without data from the GLIFWC/IPAW survey).

Overall the prioritized list for the ceded territories matches well with other regional lists and field observations. In practice, local inventory data should be substituted for the regional herbarium data for smaller scale management applications. Nevertheless, the regional lists provide a solid foundation to build on, and can help guide initial data collection at the local management scale. Figure 9 illustrates the application of this method to local distribution data collected in 2001. Tables 3 and 4 list the species detected during 2001 field surveys by local management categories.

Future inventories should be conducted annually with the goal of surveying non-native plant populations throughout the ceded territories (Figure 10). Special emphasis should be placed on detecting species on the local watch list (Appendix J). Inventories should target likely points of introduction and be repeated throughout the growing season to account for each species' varying phenology. "Watch" species should be eradicated immediately upon detection if possible and locations recorded so that control efforts can be evaluated. Management category 2 species should be further evaluated to determine if an active control program can be coordinated with GLIFWC's ongoing purple loosestrife control efforts.

The database compiled during this project will be used in the near future to target educational outreach efforts and identify more specific threats to treaty resources. For many species, human activities are the primary vectors facilitating their introduction and spread. There is a wealth of information available on potential anthropogenic sources of introduction (*e.g.* horticulture, erosion control seed mixes, etc.) that could be used to identify target audiences for educational outreach efforts. Also, by linking the habitat fields of the invasive plant database with similar fields in satellite landcover data, it will be possible to identify threats by habitat and prioritize them for survey and control efforts according to their relative distribution on the landscape.

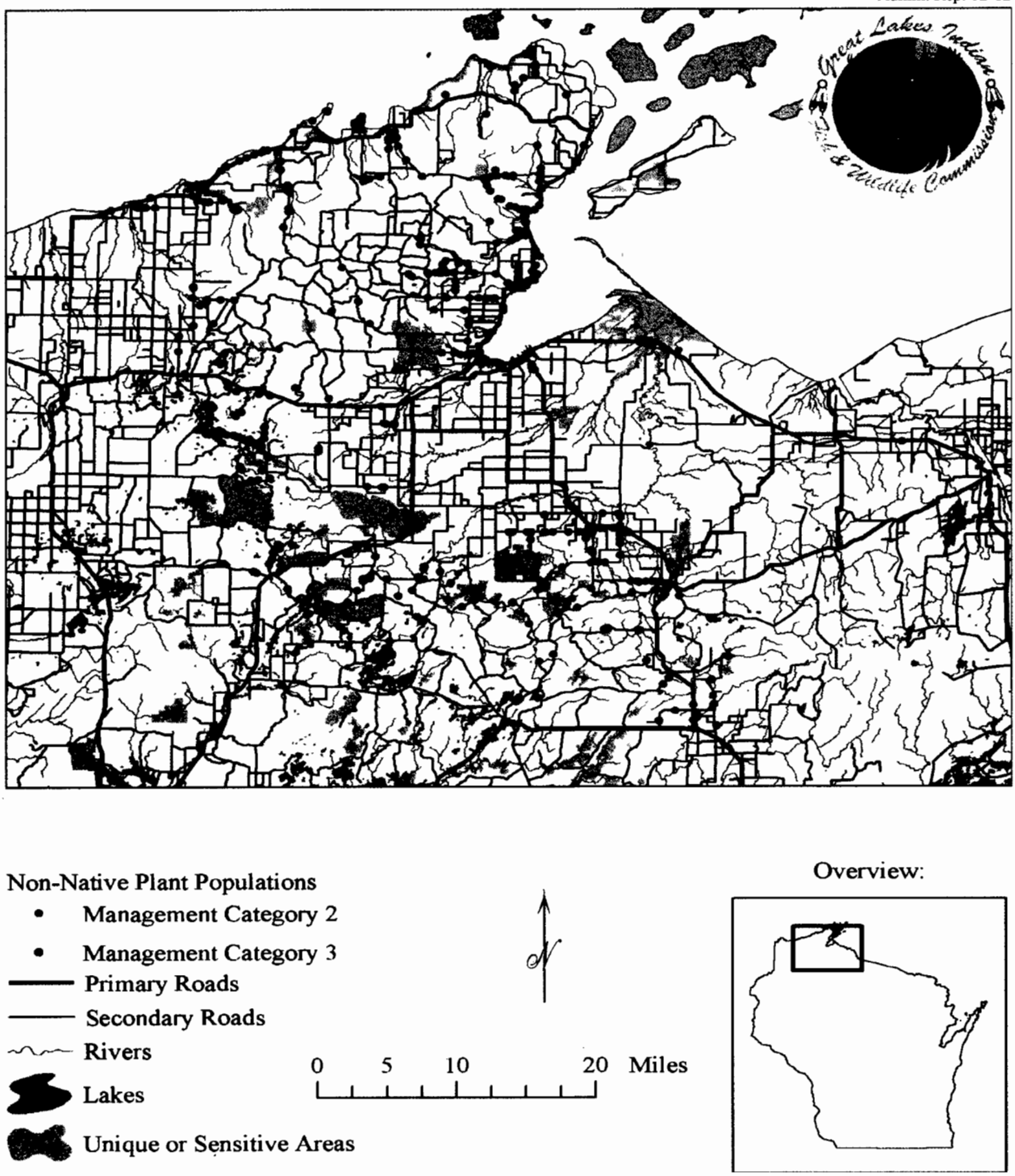


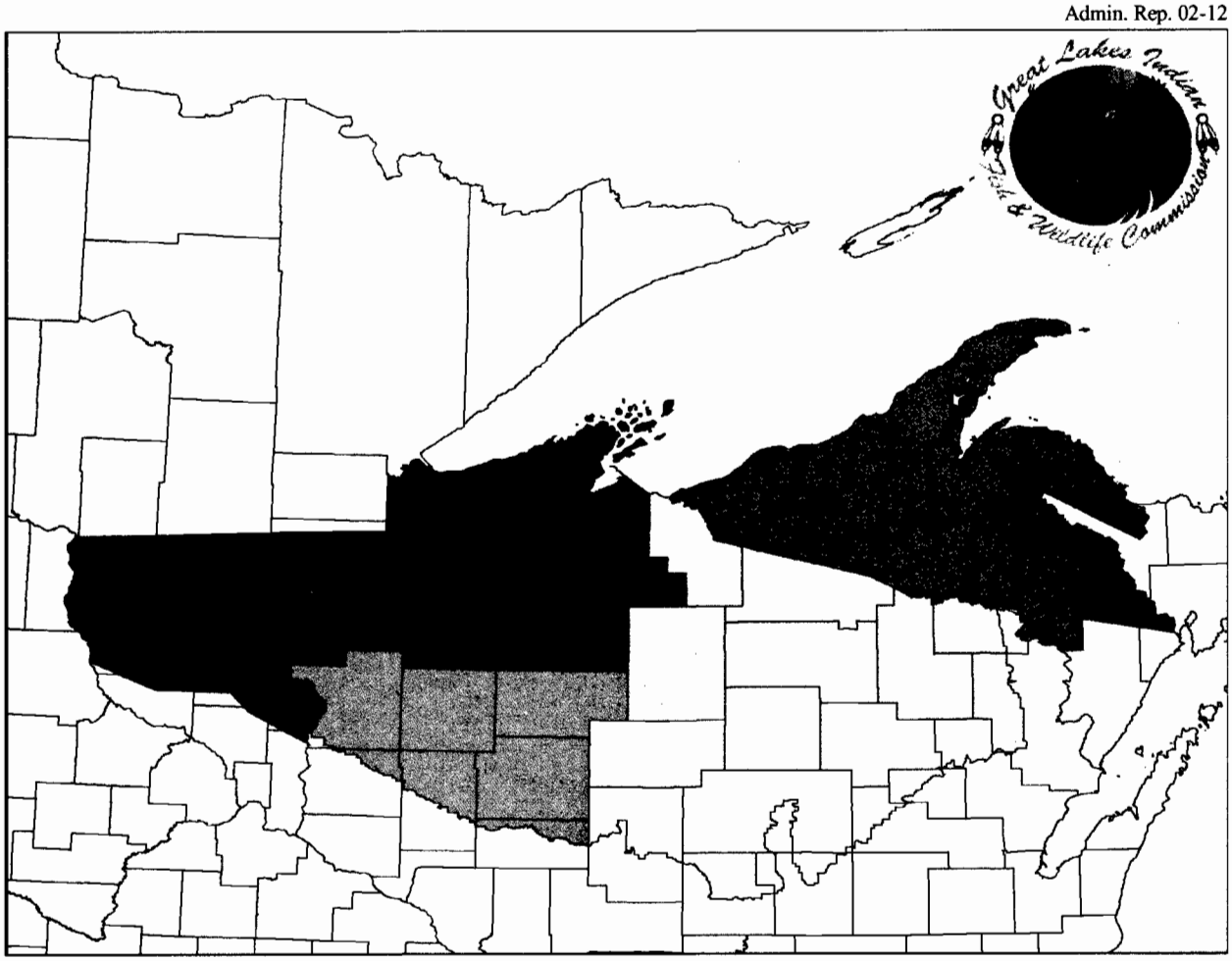
Figure 9. Non-native plant populations detected in 2001 for management categories 2 and 3.

Table 3. Summary of local management category 2 species detected in 2001.

Taxon	Common Name	Local Management Priority	Local Management Category	Regional Management Category
Euphorbia esula	Leafy spurge	0.461	2	2
Euphorbia cyparissias	Cypress spurge	0.277	2	2
Robinia pseudoacacia	Black locust	0.275	2	2
Rhamnus cathartica	Common buckthorn	0.258	2	2
Rhamnus frangula	Glossy buckthorn	0.245	2	2
Lonicera spp.	European bush honeysuckles	0.242	2	2
Polygonum sachalinense	Giant knotweed	0.231	2	2
Vinca minor	Lesser periwinkle	0.216	2	2
Convallaria majalis	European lily of the valley	0.215	2	2
Filipendula ulmaria	Queen of the meadow	0.202	2	2
Berberis thunbergii	Japanese barberry	0.200	2	2
Linaria dalmatica	Dalmatian toadflax	0.183	2	2
Centaurea maculosa	Spotted knapweed	0.175	2	2
Knautia arvensis	Blue buttons	0.164	2	2
Elaeagnus angustifolia	Russian olive	0.158	2	2
Elaeagnus umbellata	Autumn olive	0.158	2	2
Ulmus pumila	Siberian elm	0.129	2	2
Pastinaca sativa	Wild parsnip	0.125	2	3
Iris pseudacorus	Yellow flag	0.115	2	2
Calamagrostis epigejos	Feathertop	0.095	2	2
Rosa eglanteria	Sweetbriar rose	0.095	2	2
Ranunculus repens	Creeping buttercup	0.094	2	3
Anthoxanthum odoratum	Sweet vernal grass	0.094	2	2
Miscanthus sacchariflorus	Amur silver grass	0.093	2	2
Caragana arborescens	Siberian pea shrub	0.083	2	2
Coronilla varia	Crown vetch	0.075	2	3
Solanum dulcamara	Bittersweet nightshade	0.067	2	4
Veronica officinalis	Common speedwell	0.061	2	4
Campanula rapunculoides	Creeping bellflower	0.059	2	4
Acer platanoides	Norway maple	0.053	2	3

Table 4. Summary of local management category 3 species detected in 2001.

Taxon	Common Name	Local Management Priority	Local Management Category	Regional Management Category
Lathyrus latifolius	Everlasting pea	0.047	3	3
Rumex acetosa	Green sorrel	0.047	3	3
Thymus pulegioides	Wild thyme	0.047	3	3
Galium verum	Yellow bedstraw	0.047	3	3
Lathyrus tuberosus	Tuberous vetchling	0.047	3	3
Sorbaria sorbifolia	False spiraea	0.047	3	3
Viburnum lantana	Wayfaring tree	0.047	3	3
Sorbus aucuparia	Eurasian mountain ash	0.046	3	3
Achillea ptarmica	Sneezeweed	0.045	3	3
Leonurus cardiaca	Motherwort	0.022	3	4
Lathyrus sylvestris	Everlasting pea	0.020	3	3
Salix fragilis, S. alba	Crack willow, white willow	0.005	3	3
Saponaria officinalis	Soapwort	0.001	3	4
Mentha x gentilis	Scotch mint	-0.000	3	4
Aegopodium podagraria	Goutweed	-0.003	3	4
Valeriana officinalis	Garden heliotrope	-0.004	3	4
Rorippa nasturtium-aquaticum	Watercress	-0.021	3	4
Phalaris arundinacea	Reed canary grass	-0.036	3	3
Lychnis viscaria	German catchfly	-0.048	3	4
Setaria faberi	Giant foxtail	-0.049	3	4
Phlox paniculata	Garden phlox	-0.050	3	4
Typha x glauca	Hybrid cattail	-0.063	3	2
Typha angustifolia	Narrow-leaved cattail	-0.088	3	2
Linaria vulgaris	Butter-and-eggs	-0.089	3	3
Cirsium vulgare	Bull thistle	-0.090	3	3
Myosotis sylvatica	Garden forget-me-not	-0.141	3	2
Cirsium arvense	Canada thistle	-0.155	3	4
Hieracium aurantiacum	Orange hawkweed	-0.157	3	4
Arctium minus	Common burdock	-0.165	3	4
Festuca ovina	Sheep fescue	-0.167	3	2
Lotus corniculatus	Bird's-foot trefoil	-0.175	3	3



Survey Blocks:
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008

N

0 25 50 100 Miles

Figure 10. Proposed invasive plant survey blocks and schedule within the ceded territories.

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APPENDIX A

GLIFWC/IPAW Survey Instructions

Greetings,

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and the Invasive Plant Association of Wisconsin (IPAW) seek your help in developing and prioritizing a list of non-native invasive plants that threaten native plant communities in Wisconsin. Although similar lists have been developed previously, it is not always clear how they were derived and how independent they are.

Our objective is to develop a prioritized list that ranks each species from a *consistent set of ecological criteria and methods*. Our approach is adapted from the *Alien Plant Ranking System* (Hiebert, R.D. and J. Stubbendieck. 1993. Handbook for ranking exotic plants for management and control. USDI National Park Service Natural Resources Report NPS/NRMWRO/NRR-93/08. 31pp.). Because quantitative data are lacking for many invasive species, we are supplementing existing data with expert opinion to derive a database that can be ranked by several relevant (or site-specific) factors. This survey is designed to solicit first-hand knowledge from professionals in the field.

Many of you are familiar with the concept of developing an "index of conservatism" for native plants by averaging the opinions of a panel of experts. Similarly, the median responses from this survey will be calculated and combined with data derived from published literature and plant databases to develop an "index of invasiveness".

The results of this effort, along with the database we develop, will be made available at GLIFWC's web site. Although our focus is Wisconsin, we expect the results of this effort will have wider regional applications depending on the response rate from neighboring states. Some of the potential uses of these data include:

1. formulating policy
2. information and education outreach
3. prioritizing management efforts
4. justifying management efforts
5. identifying knowledge gaps
6. discerning large-scale spatial patterns

Attached is a survey form that asks you to rate several attributes and impacts for each plant. **Please limit your responses to only those species with which you have personal experience**. We have started with a comprehensive list comprised of the U.S. Forest Service's list of invasive plants for the Eastern Region and the University of Wisconsin Herbarium's list of ecologically invasive plants (nomenclature follows Gleason and Cronquist 1991). If you are aware of other problem species not included on the list, please add them in the spaces provided. Similarly, if you disagree with the listing of a species, please note that too.

You will need the acrobat reader to print out the survey. It can be downloaded for free at: http://www.adobe.com/products/acrobat/readstep.html. We would appreciate receiving your response by 30 March 2002 at the address listed below:

Invasive Plant Survey
Great Lakes Indian Fish & Wildlife Commission
P.O. Box 9
Odanah, WI 54861
ATTN: Miles Falck

Thank you for your cooperation in this effort. If you have questions pertaining to this survey, please forward them to Miles Falck at (715) 682-6619 or miles@glifwc.org.

Sincerely,

Miles Falck, Wildlife Biologist
Great Lakes Indian Fish & Wildlife Commission

Eric Parker & Heather Patti, Co-Chairs, Science Committee
Invasive Plant Association of Wisconsin

PERSONAL DATA:

Name: _____ Mailing Address: _____

Position: _____ _____

Affiliation: _____ Phone: _____

Email: _____

Geographic Work Area:

State: _____

Counties: _____

COMMENTS: (*e.g.* emerging invasive species, successful control methods, research questions, etc.)

APPENDIX A

GLIFWC/IPAW Survey Instructions

SURVEY INSTRUCTIONS: Please use this page as a guide for filling out the survey. Limit your responses to only those species you are familiar with. If you are unsure of one of the categories below for a given species, leave it blank.

Ecoregion - Refer to the map and record the ecoregion(s) where you have observed this plant..

Habitat - Plant community most often invaded (record all that apply)

A	aquatic
B	barrens
G	grasslands
F	forests
W	wetlands
D	disturbed ground

Disturbance - This plant is found:

0	only in sites disturbed within the last 3 years
5	in sites disturbed within the last 10 years
10	in mid-successional sites disturbed 11-50 years before present (BP)
15	in late-successional sites disturbed 51-100 years BP
20	in high-quality natural areas with no known major disturbance in the last 100 years

Abundance - Within my geographic work area, this plant occurs:

0	in <10% of vulnerable sites
5	in 10-25% of vulnerable sites
10	in 25-50% of vulnerable sites
15	in >50% of vulnerable sites

Impact - At sites where it occurs, this plant

0	has little or no ecological impact
5	invades and modifies native communities
10	invades and replaces native communities

Competition - Observed ability of the plant to compete for limiting resources

0	poor competitor
5	moderate competitor
10	highly competitive

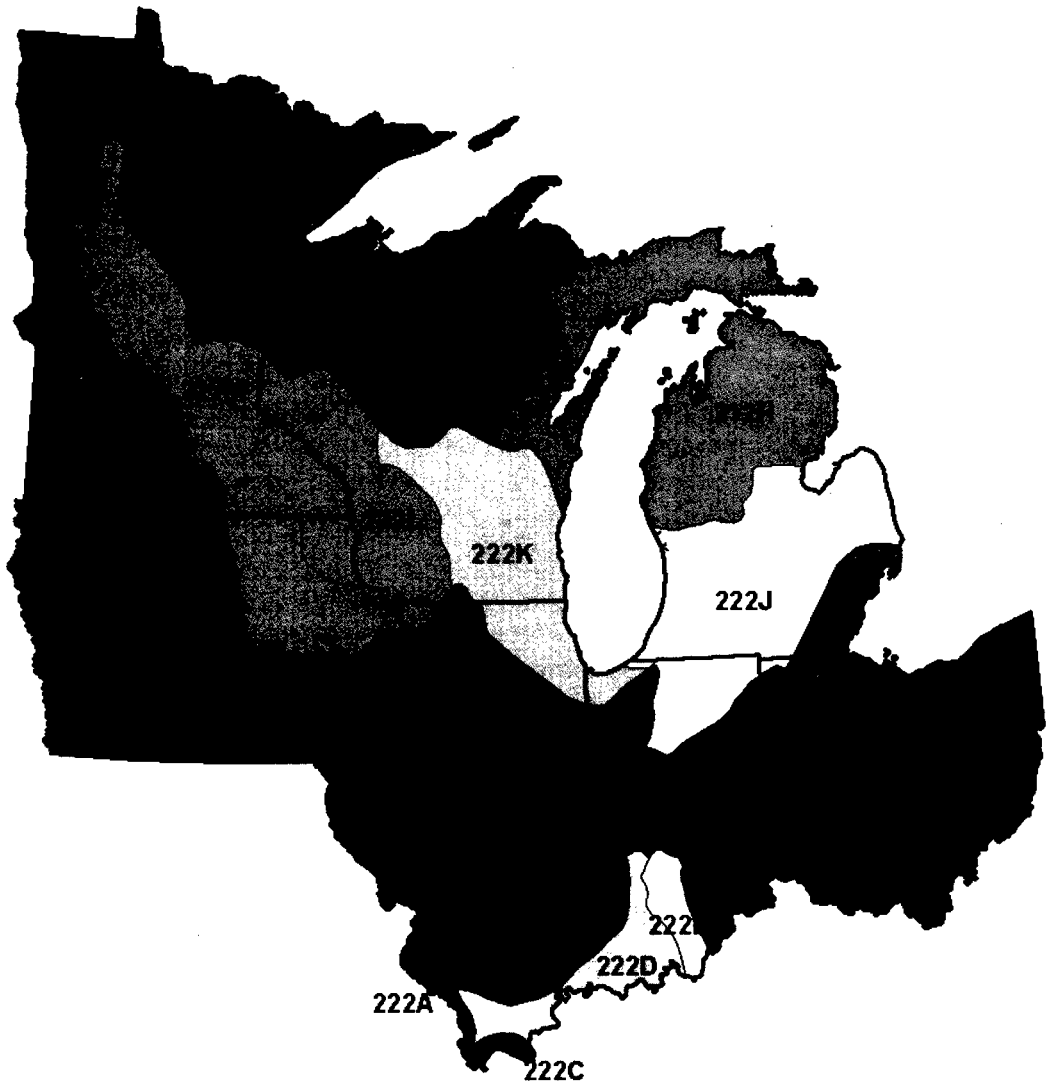
Rate of Spread - Within the last 5 years, this plant's population has

0	decreased
5	remained the same
10	increased slightly
15	more than doubled

Control - Feasibility of effective long term control

0	None required, plant will lose vigor as succession proceeds
5	One time management application
10	Periodic management required (every 5-10 years)
15	Requires annual management
20	No feasible control option

APPENDIX A
GLIFWC/IPAW Survey Instructions



APPENDIX B

Management category, relative abundance, feasibility of control, and management priority for all habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Centaurea repens	Russian knapweed	1	0.000	0.278	1.103
Hydrilla verticillata	Hydrilla	1	0.000	0.278	1.103
Ampelamus albidus	Sandvine	1	0.000	0.333	1.095
Cabomba caroliniana	Fanwort	1	0.000	0.333	1.095
Marsilea quadrifolia	Water clover	1	0.000	0.333	1.095
Najas minor	Naiad	1	0.000	0.333	1.095
Pachysandra terminalis	Pachysandra	1	0.000	0.333	1.095
Viburnum plicatum	Japanese snowball	1	0.000	0.333	1.095
Rorippa microphylla	Watercress	1	0.000	0.625	1.089
Ludwigia peploides	Creeping primrose	1	0.000	0.306	1.075
Actinidia arguta	Bower actinidia	1	0.000	0.333	1.048
Alnus glutinosa	Black alder	1	0.000	0.333	1.048
Angelica sylvestris	Woodland angelica	1	0.000	0.333	1.048
Aralia elata	Japanese angelica tree	1	0.000	0.333	1.048
Arctium vulgare	Woodland burdock	1	0.000	0.333	1.048
Cardamine pratensis var. pratensis	Cuckoo flower	1	0.000	0.333	1.048
Deschampsia cespitosa var. parviflora	Small-flowered tickle-grass	1	0.000	0.333	1.048
Euonymus alatus	Winged euonymus	1	0.000	0.333	1.048
Hydrocharis morsus-ranae	European frogbit	1	0.000	0.333	1.048
Lepidium latifolium	Tall pepperwort	1	0.000	0.333	1.048
Phellodendron amurense	Amur cork tree	1	0.000	0.333	1.048
Polygonum aubertii	Silver lace vine	1	0.000	0.333	1.048
Rhamnus citrifolia	Dahurian buckthorn	1	0.000	0.333	1.048
Rhodotypos scandens	Black jetbead	1	0.000	0.333	1.048
Rorippa amphibia	Great water cress	1	0.000	0.333	1.048
Sonchus palustris	Marsh sow thistle	1	0.000	0.333	1.048
Taxus cuspidata	Japanese yew	1	0.000	0.333	1.048
Urtica dioica var. dioica	Stinging nettle	1	0.000	0.333	1.048
Vincetoxicum nigrum	Black swallow wort	1	0.000	0.333	1.048

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Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Akebia quinata	Five-leaf akebia	1	0.000	0.333	1.048
Crassula helmsii	Australian stonecrop	1	0.000	0.333	1.048
Glyceria maxima	Tall mannagrass	1	0.000	0.333	1.048
Hedera helix	English ivy	1	0.000	0.333	1.048
Ilex crenata	Japanese holly	1	0.000	0.333	1.048
Rubus phoenicolasius	Wineberry	1	0.000	0.333	1.048
Stratiotes aloides	Water aloe	1	0.000	0.333	1.048
Tussilago farfara	Coltsfoot	1	0.000	0.333	1.048
Wisteria floribunda	Japanese wisteria	1	0.000	0.333	1.048
Salvinia molesta	Kariba weed	1	0.000	0.306	1.028
Betula pendula	Weeping birch	1	0.000	0.333	1.000
Brachypodium sylvaticum	Slender false brome	1	0.000	0.333	1.000
Dipsacus fullonium	Fuller's teasel	1	0.000	0.333	1.000
Heracleum mantegazzianum	Giant hogweed	1	0.000	0.333	1.000
Pinus virginiana	Virginia pine	1	0.000	0.333	1.000
Spiraea prunifolia	Bridalwreath spirea	1	0.000	0.333	1.000
Ampelopsis brevipedunculata	Porcelain berry	1	0.000	0.333	1.000
Aralia spinosa	Hercules' club	1	0.000	0.333	1.000
Carex kobomugi	Asiatic sedge	1	0.000	0.333	1.000
Leucojum aestivum	Summer snowflake	1	0.000	0.333	1.000
Miscanthus sinensis	Eulalia	1	0.000	0.333	1.000
Phellodendron japonicum	Japanese cork tree	1	0.000	0.333	1.000
Picris hieracioides ssp. hieracioides	Oxtongue	1	0.000	0.333	1.000
Quercus robur	English oak	1	0.000	0.333	1.000
Sorghum halepense	Johnson grass	1	0.000	0.333	1.000
Viburnum dilatatum	Linden arrowwood	1	0.000	0.333	1.000
Viburnum sieboldii	Japanese viburnum	1	0.000	0.333	1.000
Geranium nepalense	Sweet Nepalese crane's bill	1	0.000	0.333	1.000
Bidens aristosa	Beggar ticks	1	0.000	0.333	1.000

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Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Egeria densa	Brazilian water weed	1	0.000	0.333	1.000
Lamium galeobdolon	Yellow dead nettle	1	0.000	0.333	1.000
Lespedeza stipulacea	Korean clover	1	0.000	0.333	1.000
Lespedeza striata	Bush clover	1	0.000	0.333	1.000
Ranunculus ficaria	Lesser celandine	1	0.000	0.333	1.000
Torilis arvensis	Field hedge-parsley	1	0.000	0.333	1.000
Trapa natans	Water chestnut	1	0.000	0.333	1.000
Setaria glauca	Yellow foxtail	1	0.000	0.472	0.997
Acer palmatum	Japanese maple	1	0.000	0.333	0.952
Chloris verticillata	Windmill grass	1	0.000	0.333	0.952
Ulmus parvifolia	Chinese elm	1	0.000	0.333	0.952
Vincetoxicum rossicum	Swallow wort	1	0.000	0.333	0.952
Bothriochloa bladhii	Eurasian bluestem	1	0.000	0.333	0.952
Nymphoides peltata	Yellow floating heart	1	0.000	0.333	0.952
Aira caryophyllea	Silver hairgrass	1	0.000	0.333	0.952
Arthraxon hispidus	Small carpgrass	1	0.000	0.333	0.952
Elsholtzia ciliata	Elsholtzia	1	0.000	0.333	0.952
Humulus japonicus	Japanese hops	1	0.000	0.333	0.952
Microstegium vimineum	Japanese stilt grass	1	0.000	0.333	0.952
Perilla frutescens	Perilla	1	0.000	0.333	0.952
Poa bulbosa	Bulbous bluegrass	1	0.000	0.333	0.952
Dioscorea batatas	Cinnamon vine	1	0.000	0.333	0.952
Panicum amarum	Beach grass	1	0.000	0.333	0.952
Celastrus orbiculatus	Oriental bittersweet	1	0.000	0.625	0.946
Pinus thunbergiana	Japanese black pine	1	0.000	0.306	0.933
Eragrostis curvula	African weeping lovegrass	1	0.000	0.333	0.905
Lunaria rediviva	Money plant	1	0.000	0.333	0.905
Paulownia tomentosa	Empress tree	1	0.000	0.333	0.905
Cardamine impatiens	Bushy rock cress	1	0.000	0.333	0.905

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Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Phyllostachys spp.	Oriental bamboo	1	0.000	0.333	0.905
Polygonum cespitosum	Smartweed	1	0.000	0.583	0.905
Polygonum perfoliatum	Mile-a-minute vine	1	0.000	0.333	0.905
Hieracium lachenalii	Hawkweed	2	0.071	0.357	0.548
Euphorbia esula	Leafy spurge	2	0.439	0.463	0.334
Lonicera japonica	Japanese honeysuckle	2	0.010	0.545	0.300
Lythrum salicaria	Purple loosestrife	2	0.429	0.605	0.266
Rosa multiflora	Multiflora rose	2	0.051	0.573	0.261
Butomus umbellatus	Flowering rush	2	0.041	0.430	0.260
Centaurea maculosa	Spotted knapweed	2	0.786	0.506	0.247
Lysimachia vulgaris	Garden loosestrife	2	0.031	0.469	0.246
Polygonum sachalinense	Giant knotweed	2	0.051	0.350	0.221
Rhamnus cathartica	Common buckthorn	2	0.204	0.651	0.205
Alliaria petiolata	Garlic mustard	2	0.092	0.614	0.203
Filipendula ulmaria	Queen of the meadow	2	0.031	0.427	0.192
Typha x glauca	Hybrid cattail	2	0.261	0.698	0.183
Myriophyllum spicatum	Eurasian water milfoil	2	0.173	0.646	0.179
Robinia pseudoacacia	Black locust	2	0.316	0.536	0.178
Rhamnus frangula	Glossy buckthorn	2	0.265	0.665	0.177
Senecio jacobaea	Tansy ragwort	2	0.010	0.253	0.175
Convallaria majalis	European lily of the valley	2	0.143	0.492	0.169
Epipactis helleborine	Helleborine	2	0.071	0.579	0.165
Centaurea diffusa	Diffuse knapweed	2	0.163	0.082	0.156
Elaeagnus angustifolia	Russian olive	2	0.010	0.559	0.155
Cirsium palustre	Marsh thistle	2	0.276	0.675	0.151
Vinca minor	Greater periwinkle	2	0.214	0.655	0.147
Elaeagnus umbellata	Autumn olive	2	0.041	0.569	0.145
Lonicera maackii	Amur honeysuckle	2	0.031	0.594	0.145
Euphorbia cyparissias	Cypress spurge	2	0.408	0.469	0.142

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Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Typha angustifolia	Narrow-leaved cattail	2	0.327	0.642	0.136
Knautia arvensis	Field scabious	2	0.102	0.367	0.133
Berberis thunbergii	Japanese barberry	2	0.214	0.583	0.132
Linaria dalmatica	Dalmatian toadflax	2	0.194	0.259	0.122
Lysimachia nummularia	Moneywort	2	0.122	0.707	0.114
Galium mollugo	Wild madder	2	0.112	0.496	0.111
Lonicera spp.	European bush honeysuckles	2	0.551	0.701	0.104
Euonymus europaeus	Spindle tree	2	0.010	0.337	0.092
Hieracium x atramentarium	Hawkweed	2	0.010	0.337	0.092
Carduus acanthoides	Plumeless thistle	2	0.122	0.291	0.090
Calamagrostis epigejos	Feathertop	2	0.020	0.340	0.088
Geranium pratense	Wild geranium	2	0.020	0.340	0.088
Mentha aquatica	Water mint	2	0.020	0.340	0.088
Sedum kamtschaticum	Kamtschatica stonecrop	2	0.020	0.340	0.088
Pinus sylvestris	Scotch pine	2	0.043	0.466	0.087
Miscanthus sacchariflorus	Amur silver grass	2	0.031	0.344	0.085
Iris pseudacorus	Yellow Iris	2	0.092	0.614	0.084
Myosotis sylvatica	Garden forget-me-not	2	0.337	0.571	0.080
Lupinus polyphyllus	Bigleaf lupine	2	0.143	0.575	0.073
Ulmus pumila	Siberian elm	2	0.173	0.641	0.073
Carduus nutans	Musk thistle	2	0.031	0.260	0.073
Hesperis matronalis	Dame's rocket	2	0.337	0.696	0.065
Rosa rugosa	Beach rose	2	0.112	0.371	0.058
Anthoxanthum odoratum	Sweet vernal grass	2	0.133	0.544	0.057
Centaurea solstitialis	Yellow starthistle	2	0.031	0.232	0.053
Caragana arborescens	Siberian pea shrub	2	0.092	0.531	0.053
Potamogeton crispus	Curly pondweed	2	0.347	0.741	0.050
Viburnum opulus var. opulus	European cranberry bush	2	0.067	0.606	0.049
Rosa eglanteria	Sweetbriar	2	0.143	0.381	0.048

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Festuca ovina	Sheep fescue	2	0.367	0.539	0.044
Clematis terniflora	Yam-leaved clematis	2	0.010	0.337	0.044
Maclura pomifera	Osage orange	2	0.010	0.337	0.044
Euonymus fortunei	Climbing euonymus	2	0.010	0.337	0.044
Wisteria sinensis	Chinese wisteria	2	0.010	0.337	0.044
Ranunculus repens	Creeping buttercup	3	0.162	0.387	0.041
Ligustrum obtusifolium	Amur river privet	3	0.020	0.340	0.041
Prunus avium	Sweet cherry	3	0.020	0.340	0.041
Onopordum acanthium	Scotch thistle	3	0.020	0.340	0.041
Aruncus dioicus	Goat's beard	3	0.031	0.344	0.037
Ligustrum vulgare	European privet	3	0.031	0.344	0.037
Lonicera xylosteum	European fly honeysuckle	3	0.031	0.344	0.037
Rumex acetosa	Green sorrel	3	0.041	0.347	0.034
Acer platanoides	Norway maple	3	0.061	0.479	0.033
Coronilla varia	Crown vetch	3	0.235	0.703	0.031
Leontodon autumnalis	Fall dandelion	3	0.051	0.350	0.031
Viburnum lantana	Wayfaring tree	3	0.051	0.350	0.031
Ajuga reptans	Carpet bugle	3	0.092	0.614	0.029
Arrhenatherum elatius	Tall oatgrass	3	0.061	0.354	0.027
Sorbus aucuparia	Eurasian mountain ash	3	0.061	0.354	0.027
Thymus serpyllum	Thyme	3	0.061	0.354	0.027
Hemerocallis fulva	Orange daylily	3	0.296	0.724	0.026
Lotus corniculatus	Bird's-foot trefoil	3	0.398	0.633	0.025
Humulus lupulus var. lupulus	Hops	3	0.067	0.356	0.025
Achillea millefolium var. millefolium	Common yarrow	3	0.267	0.589	0.024
Sedum purpureum	Live forever	3	0.214	0.405	0.024
Lathyrus tuberosus	Tuberous vetchling	3	0.082	0.361	0.020
Thymus pulegioides	Wild thyme	3	0.082	0.361	0.020
Epilobium hirsutum	Hairy willow herb	3	0.082	0.361	0.020

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Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Populus alba	White poplar	3	0.184	0.533	0.014
Mentha x piperita	Peppermint	3	0.245	0.415	0.014
Prunella vulgaris var. vulgaris	Heal-all	3	0.200	0.633	0.012
Kochia scoparia	Summer cypress	3	0.153	0.551	0.009
Galium verum	Yellow bedstraw	3	0.122	0.374	0.007
Ribes sativum	Garden red currant	3	0.122	0.374	0.007
Cirsium vulgare	Bull thistle	3	0.714	0.653	0.005
Polygonum cuspidatum	Japanese knotweed	3	0.204	0.672	0.004
Achillea ptarmica	Sneezeweed	3	0.133	0.378	0.003
Acer pseudoplatanus	Sycamore maple	3	0.010	0.337	-0.003
Spiraea japonica	Japanese spiraea	3	0.010	0.337	-0.003
Callitriche stagnalis	European water starwort	3	0.010	0.337	-0.003
Abutilon theophrasti	Velvet leaf	3	0.071	0.440	-0.004
Conium maculatum	Poison hemlock	3	0.102	0.340	-0.006
Sorbaria sorbifolia	False Spiraea	3	0.163	0.388	-0.007
Impatiens glandulifera	Purple jewelweed	3	0.020	0.340	-0.007
Acer ginnala	Amur maple	3	0.031	0.344	-0.010
Anthriscus sylvestris	Wild chervil	3	0.031	0.344	-0.010
Centaurea nigra	Black knapweed	3	0.031	0.344	-0.010
Lathyrus sylvestris	Everlasting pea	3	0.173	0.391	-0.010
Pastinaca sativa	Wild parsnip	3	0.429	0.685	-0.013
Dipsacus laciniatus	Cut-leaved teasel	3	0.041	0.347	-0.014
Lamium maculatum	Red dead nettle	3	0.041	0.347	-0.014
Poa trivialis	Rough bluegrass	3	0.044	0.348	-0.015
Centaurea dubia	Short-fringed knapweed	3	0.051	0.350	-0.017
Lespedeza cuneata	Chinese lespedeza	3	0.051	0.350	-0.017
Phalaris arundinacea	Reed canary grass	3	0.957	0.944	-0.022
Vicia cracca	Cow vetch	3	0.184	0.624	-0.024
Ailanthus altissima	Tree of heaven	3	0.071	0.357	-0.024

APPENDIX B

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Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Lathyrus latifolius	Everlasting pea	3	0.214	0.405	-0.024
Symphytum officinale	Comfrey	3	0.214	0.405	-0.024
Daucus carota	Queen Anne's lace	3	0.469	0.676	-0.026
Salix spp.	Crack & white willows	3	0.286	0.540	-0.028
Linaria vulgaris	Butter and eggs	3	0.816	0.589	-0.028
Centaurea x pratensis	Meadow knapweed	4	0.092	0.364	-0.031
Aegopodium podagraria	Goutweed	4	0.092	0.364	-0.031
Berberis vulgaris	Common barberry	4	0.102	0.367	-0.034
Torilis japonica	Japanese hedge-parsley	4	0.031	0.677	-0.034
Dipsacus sylvestris	Common teasel	4	0.112	0.371	-0.037
Mentha x gentilis	Scotch mint	4	0.112	0.371	-0.037
Morus alba	White mulberry	4	0.112	0.371	-0.037
Mentha spicata	Spearmint	4	0.122	0.374	-0.041
Arctium minus	Common burdock	4	0.633	0.700	-0.043
Rumex obtusifolius	Bitter dock	4	0.541	0.514	-0.049
Agrostis stolonifera	Creeping bent	4	0.296	0.626	-0.049
Hieracium piloselloides	Yellow hawkweed	4	0.592	0.781	-0.051
Ornithogalum umbellatum	Star of Bethlehem	4	0.010	0.337	-0.051
Lychnis viscaria	German catchfly	4	0.010	0.337	-0.051
Centaurea cyanus	Bachelor's buttons	4	0.102	0.340	-0.054
Veronica officinalis	Speedwell	4	0.367	0.678	-0.054
Prunus mahaleb	Perfumed cherry	4	0.020	0.340	-0.054
Centaurea jacea	Brown knapweed	4	0.173	0.391	-0.058
Valeriana officinalis	Garden heliotrope	4	0.214	0.738	-0.060
Festuca pratensis	Meadow fescue	4	0.184	0.395	-0.061
Bromus squarrosus	Corn brome	4	0.041	0.347	-0.061
Digitalis lanata	Grecian foxglove	4	0.041	0.347	-0.061
Lactuca serriola	Prickly lettuce	4	0.316	0.522	-0.062
Cirsium arvense	Canada thistle	4	0.724	0.818	-0.063

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Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Artemisia absinthium	Common wormwood	4	0.408	0.469	-0.065
Chelidonium majus	Greater celandine	4	0.051	0.350	-0.065
Froelichia gracilis	Cottonweed	4	0.051	0.350	-0.065
Lunaria annua	Money plant	4	0.051	0.350	-0.065
Phalaris canariensis	Canary grass	4	0.061	0.354	-0.068
Robinia hispida	Rose-acacia	4	0.061	0.354	-0.068
Verbascum blattaria	Moth muellin	4	0.204	0.401	-0.068
Cytisus scoparius	Scotch Broom	4	0.010	0.309	-0.071
Commelina communis	Dayflower	4	0.071	0.357	-0.071
Setaria faberi	Giant foxtail	4	0.071	0.357	-0.071
Digitalis purpurea	Foxglove	4	0.082	0.361	-0.075
Campanula rapunculoides	Creeping bellflower	4	0.418	0.667	-0.078
Bromus japonicus	Japanese brome	4	0.092	0.364	-0.078
Datura stramonium	Jimsonweed	4	0.102	0.367	-0.082
Panicum miliaceum	Broomcorn millet	4	0.118	0.373	-0.087
Echium vulgare	Viper's bugloss	4	0.276	0.425	-0.092
Bromus inermis	Smooth brome	4	0.694	0.815	-0.093
Cannabis sativa	Hemp	4	0.143	0.381	-0.095
Galinsoga quadriradiata	Quickweed	4	0.286	0.429	-0.095
Cichorium intybus	Chicory	4	0.469	0.640	-0.097
Fumaria officinalis	Fumitory	4	0.010	0.337	-0.099
Lychnis flos-cuculi	Ragged robin	4	0.010	0.337	-0.099
Cynoglossum officinale	Hound's tongue	4	0.408	0.636	-0.100
Sonchus oleraceus	Common sow thistle	4	0.173	0.724	-0.105
Glechoma hederacea	Gill over the ground	4	0.480	0.795	-0.106
Festuca elatior	Tall fescue	4	0.255	0.668	-0.109
Allium vineale	Wild garlic	4	0.041	0.347	-0.109
Gypsophila paniculata	Baby's breath	4	0.184	0.395	-0.109
Myosotis scorpioides	Forget-me-not	4	0.510	0.781	-0.111

APPENDIX B

Management category, relative abundance, feasibility of control, and management priority for all habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Crepis tectorum	Hawksbeard	4	0.398	0.688	-0.111
Centaurium pulchellum	Branching centaury	4	0.051	0.350	-0.112
Odontites serotina	Eyebright	4	0.051	0.350	-0.112
Tanacetum vulgare	Tansy	4	0.673	0.756	-0.116
Hieracium aurantiacum	Orange hawkweed	4	0.878	0.876	-0.117
Asparagus officinalis	Asparagus	4	0.480	0.618	-0.118
Solanum dulcamara	Climbing nightshade	4	0.571	0.774	-0.119
Ranunculus acris var. acris	Tall buttercup	4	0.724	0.700	-0.120
Phlox paniculata	Garden phlox	4	0.224	0.408	-0.122
Leonurus cardiaca	Motherwort	4	0.439	0.667	-0.124
Echinochloa crusgalli	Barnyard grass	4	0.398	0.563	-0.131
Poa annua	Annual bluegrass	4	0.324	0.608	-0.132
Salix babylonica	Weeping willow	4	0.041	0.555	-0.139
Arenaria serpyllifolia	Thyme-leaf sandwort	4	0.357	0.452	-0.143
Rorippa nasturtium-aquaticum	Watercress	4	0.378	0.793	-0.146
Glaucium flavum	Horned poppy	4	0.010	0.337	-0.146
Tragopogon pratensis	Yellow goat's beard	4	0.449	0.677	-0.147
Trifolium repens	White clover	4	0.796	0.789	-0.148
Sonchus asper	Prickly sow thistle	4	0.388	0.713	-0.149
Bromus tectorum	Downy chess	4	0.306	0.435	-0.150
Plantago lanceolata	Plantain	4	0.663	0.763	-0.152
Hypericum perforatum	St. John's wort	4	0.724	0.753	-0.158
Taraxacum officinale	Common dandelion	4	0.786	0.804	-0.165
Dactylis glomerata	Orchard-grass	4	0.439	0.702	-0.165
Poa compressa	Canada bluegrass	4	0.706	0.798	-0.173
Sonchus arvensis	Field sow thistle	4	0.796	0.890	-0.174
Convolvulus arvensis	Field bindweed	4	0.347	0.682	-0.182
Stellaria media	Common chickweed	4	0.418	0.473	-0.187
Poa pratensis	Kentucky bluegrass	4	0.813	0.863	-0.191

APPENDIX B

Management category, relative abundance, feasibility of control, and management priority for all habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Elytrigia repens	Quackgrass	4	0.755	0.823	-0.197
Melilotus officinalis	Yellow sweet clover	4	0.704	0.843	-0.201
Thlaspi arvense	Field pennycress	4	0.378	0.654	-0.201
Potentilla recta	Sulphur cinquefoil	4	0.827	0.692	-0.202
Medicago lupulina	Black medic	4	0.622	0.728	-0.204
Rumex acetosella	Sheep sorrell	4	0.908	0.830	-0.204
Phleum pratense	Timothy	4	0.806	0.727	-0.204
Stellaria graminea	Common stitchwort	4	0.378	0.793	-0.209
Trifolium pratense	Red clover	4	0.857	0.786	-0.210
Malva neglecta	Common mallow	4	0.469	0.601	-0.214
Rumex crispus	Curly dock	4	0.684	0.783	-0.219
Saponaria officinalis	Soapwort	4	0.684	0.867	-0.224
Amaranthus retroflexus	Redroot pigweed	4	0.449	0.700	-0.226
Chrysanthemum leucanthemum	Ox-eye daisy	4	0.857	0.780	-0.231
Melilotus alba	White sweet clover	4	0.796	0.883	-0.233
Nepeta cataria	Catnip	4	0.582	0.694	-0.241
Sedum acre	Yellow sedum	4	0.316	0.772	-0.248
Verbascum thapsus	Giant muellin	4	0.878	0.786	-0.264
Plantago major	Plantain	4	0.816	0.786	-0.270
Galeopsis tetrahit	Hemp nettle	4	0.622	0.791	-0.273
Stellaria aquatica	Giant chickweed	4	0.276	0.759	-0.282
Matricaria matricarioides	Pineapple weed	4	0.745	0.707	-0.290
Lolium perenne	Rye grass	4	0.265	0.755	-0.295
Capsella bursa-pastoris	Shepard's purse	4	0.776	0.742	-0.297
Berteroa incana	Hoary alyssum	4	0.806	0.831	-0.305
Amaranthus hybridus	Green amaranthus	4	0.031	0.677	-0.308
Senecio vulgaris	Common groundsel	4	0.245	0.748	-0.308
Potentilla argentea	Silvery cinquefoil	4	0.888	0.824	-0.316
Lapsana communis	Nipplewort	4	0.163	0.721	-0.316

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Management category, relative abundance, feasibility of control, and management priority for all habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Malva moschata	Musk mallow	4	0.398	0.799	-0.323
Vicia villosa	Hairy vetch	4	0.776	0.842	-0.324
Cerastium vulgatum	Mouse-ear chickweed	4	0.867	0.856	-0.372
Silene vulgaris	Bladder campion	4	0.612	0.801	-0.385
Silene latifolia	White campion	4	0.929	0.810	-0.480
Dianthus armeria	Deptford pink	4	0.439	0.813	-0.495

APPENDIX C

Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Centaurea repens	Russian knapweed	1	0.000	0.278	1.103
Actinidia arguta	Bower actinidia	1	0.000	0.333	1.048
Arctium vulgare	Woodland burdock	1	0.000	0.333	1.048
Lepidium latifolium	Tall pepperwort	1	0.000	0.333	1.048
Phellodendron amurense	Amur cork tree	1	0.000	0.333	1.048
Polygonum aubertii	Silver lace vine	1	0.000	0.333	1.048
Rhodotypos scandens	Black jetbead	1	0.000	0.333	1.048
Akebia quinata	Five-leaf akebia	1	0.000	0.333	1.048
Ilex crenata	Japanese holly	1	0.000	0.333	1.048
Rubus phoenicolasius	Wineberry	1	0.000	0.333	1.048
Stratiotes aloides	Water aloe	1	0.000	0.333	1.048
Tussilago farfara	Coltsfoot	1	0.000	0.333	1.048
Wisteria floribunda	Japanese wisteria	1	0.000	0.333	1.048
Dipsacus fullonium	Fuller's teasel	1	0.000	0.333	1.000
Pinus virginiana	Virginia pine	1	0.000	0.333	1.000
Spiraea prunifolia	Bridalwreath spirea	1	0.000	0.333	1.000
Ampelopsis brevipedunculata	Porcelain berry	1	0.000	0.333	1.000
Carex kobomugi	Asiatic sedge	1	0.000	0.333	1.000
Miscanthus sinensis	Eulalia	1	0.000	0.333	1.000
Phellodendron japonicum	Japanese cork tree	1	0.000	0.333	1.000
Picris hieracioides ssp. hieracioides	Oxtongue	1	0.000	0.333	1.000
Quercus robur	English oak	1	0.000	0.333	1.000
Sorghum halepense	Johnson grass	1	0.000	0.333	1.000
Geranium nepalense	Sweet Nepalese crane's bill	1	0.000	0.333	1.000
Lespedeza stipulacea	Korean clover	1	0.000	0.333	1.000
Lespedeza striata	Bush clover	1	0.000	0.333	1.000
Torilis arvensis	Field hedge-parsley	1	0.000	0.333	1.000
Acer palmatum	Japanese maple	1	0.000	0.333	0.952
Chloris verticillata	Windmill grass	1	0.000	0.333	0.952

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Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Ulmus parvifolia	Chinese elm	1	0.000	0.333	0.952
Bothriochloa bladhii	Eurasian bluestem	1	0.000	0.333	0.952
Aira caryophyllea	Silver hairgrass	1	0.000	0.333	0.952
Elsholtzia ciliata	Elsholtzia	1	0.000	0.333	0.952
Humulus japonicus	Japanese hops	1	0.000	0.333	0.952
Dioscorea batatas	Cinnamon vine	1	0.000	0.333	0.952
Panicum amarum	Beach grass	1	0.000	0.333	0.952
Pinus thunbergiana	Japanese black pine	1	0.000	0.306	0.933
Eragrostis curvula	African weeping lovegrass	1	0.000	0.333	0.905
Lunaria rediviva	Money plant	1	0.000	0.333	0.905
Paulownia tomentosa	Empress tree	1	0.000	0.333	0.905
Cardamine impatiens	Bushy rock cress	1	0.000	0.333	0.905
Phyllostachys spp.	Oriental bamboo	1	0.000	0.333	0.905
Hieracium lachenalii	Hawkweed	2	0.071	0.357	0.548
Euphorbia esula	Leafy spurge	2	0.439	0.463	0.334
Rosa multiflora	Multiflora rose	2	0.051	0.573	0.261
Centaurea maculosa	Spotted knapweed	2	0.786	0.506	0.247
Polygonum sachalinense	Giant knotweed	2	0.051	0.350	0.221
Robinia pseudoacacia	Black locust	2	0.316	0.536	0.178
Senecio jacobaea	Tansy ragwort	2	0.010	0.253	0.175
Centaurea diffusa	Diffuse knapweed	2	0.163	0.082	0.156
Elaeagnus angustifolia	Russian olive	2	0.010	0.559	0.155
Elaeagnus umbellata	Autumn olive	2	0.041	0.569	0.145
Lonicera maackii	Amur honeysuckle	2	0.031	0.594	0.145
Euphorbia cyparissias	Cypress spurge	2	0.408	0.469	0.142
Knautia arvensis	Field scabious	2	0.102	0.367	0.133
Linaria dalmatica	Dalmatian toadflax	2	0.194	0.259	0.122
Galium mollugo	Wild madder	2	0.112	0.496	0.111
Lonicera spp.	European bush honeysuckles	2	0.551	0.701	0.104

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Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Hieracium x atramentarium	Hawkweed	2	0.010	0.337	0.092
Carduus acanthoides	Plumeless thistle	2	0.122	0.291	0.090
Geranium pratense	Wild geranium	2	0.020	0.340	0.088
Sedum kamtschaticum	Kamtschatica stonecrop	2	0.020	0.340	0.088
Pinus sylvestris	Scotch pine	2	0.043	0.466	0.087
Miscanthus sacchariflorus	Amur silver grass	2	0.031	0.344	0.085
Lupinus polyphyllus	Bigleaf lupine	2	0.143	0.575	0.073
Ulmus pumila	Siberian elm	2	0.173	0.641	0.073
Carduus nutans	Musk thistle	2	0.031	0.260	0.073
Hesperis matronalis	Dame's rocket	2	0.337	0.696	0.065
Rosa rugosa	Beach rose	2	0.112	0.371	0.058
Anthoxanthum odoratum	Sweet vernal grass	2	0.133	0.544	0.057
Centaurea solstitialis	Yellow starthistle	2	0.031	0.232	0.053
Caragana arborescens	Siberian pea shrub	2	0.092	0.531	0.053
Rosa eglanteria	Sweetbriar	2	0.143	0.381	0.048
Festuca ovina	Sheep fescue	2	0.367	0.539	0.044
Clematis terniflora	Yam-leaved clematis	2	0.010	0.337	0.044
Maclura pomifera	Osage orange	2	0.010	0.337	0.044
Wisteria sinensis	Chinese wisteria	2	0.010	0.337	0.044
Prunus avium	Sweet cherry	3	0.020	0.340	0.041
Onopordum acanthium	Scotch thistle	3	0.020	0.340	0.041
Aruncus dioicus	Goat's beard	3	0.031	0.344	0.037
Lonicera xylosteum	European fly honeysuckle	3	0.031	0.344	0.037
Rumex acetosa	Green sorrel	3	0.041	0.347	0.034
Coronilla varia	Crown vetch	3	0.235	0.703	0.031
Leontodon autumnalis	Fall dandelion	3	0.051	0.350	0.031
Arrhenatherum elatius	Tall oatgrass	3	0.061	0.354	0.027
Sorbus aucuparia	Eurasian mountain ash	3	0.061	0.354	0.027
Thymus serpyllum	Thyme	3	0.061	0.354	0.027

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Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Hemerocallis fulva	Orange daylily	3	0.296	0.724	0.026
Humulus lupulus var. lupulus	Hops	3	0.067	0.356	0.025
Achillea millefolium var. millefolium	Common yarrow	3	0.267	0.589	0.024
Sedum purpureum	Live forever	3	0.214	0.405	0.024
Lathyrus tuberosus	Tuberous vetchling	3	0.082	0.361	0.020
Thymus pulegioides	Wild thyme	3	0.082	0.361	0.020
Populus alba	White poplar	3	0.184	0.533	0.014
Kochia scoparia	Summer cypress	3	0.153	0.551	0.009
Galium verum	Yellow bedstraw	3	0.122	0.374	0.007
Ribes sativum	Garden red currant	3	0.122	0.374	0.007
Cirsium vulgare	Bull thistle	3	0.714	0.653	0.005
Polygonum cuspidatum	Japanese knotweed	3	0.204	0.672	0.004
Acer pseudoplatanus	Sycamore maple	3	0.010	0.337	-0.003
Spiraea japonica	Japanese spiraea	3	0.010	0.337	-0.003
Abutilon theophrasti	Velvet leaf	3	0.071	0.440	-0.004
Sorbaria sorbifolia	False Spiraea	3	0.163	0.388	-0.007
Acer ginnala	Amur maple	3	0.031	0.344	-0.010
Anthriscus sylvestris	Wild chervil	3	0.031	0.344	-0.010
Centaurea nigra	Black knapweed	3	0.031	0.344	-0.010
Lathyrus sylvestris	Everlasting pea	3	0.173	0.391	-0.010
Pastinaca sativa	Wild parsnip	3	0.429	0.685	-0.013
Dipsacus laciniatus	Cut-leaved teasel	3	0.041	0.347	-0.014
Centaurea dubia	Short-fringed knapweed	3	0.051	0.350	-0.017
Lespedeza cuneata	Chinese lespedeza	3	0.051	0.350	-0.017
Vicia cracca	Cow vetch	3	0.184	0.624	-0.024
Ailanthus altissima	Tree of heaven	3	0.071	0.357	-0.024
Lathyrus latifolius	Everlasting pea	3	0.214	0.405	-0.024
Symphytum officinale	Comfrey	3	0.214	0.405	-0.024
Daucus carota	Queen Anne's lace	3	0.469	0.676	-0.026

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Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Linaria vulgaris	Butter and eggs	3	0.816	0.589	-0.028
Centaurea x pratensis	Meadow knapweed	4	0.092	0.364	-0.031
Berberis vulgaris	Common barberry	4	0.102	0.367	-0.034
Torilis japonica	Japanese hedge-parsley	4	0.031	0.677	-0.034
Dipsacus sylvestris	Common teasel	4	0.112	0.371	-0.037
Arctium minus	Common burdock	4	0.633	0.700	-0.043
Hieracium piloselloides	Yellow hawkweed	4	0.592	0.781	-0.051
Lychnis viscaria	German catchfly	4	0.010	0.337	-0.051
Centaurea cyanus	Bachelor's buttons	4	0.102	0.340	-0.054
Prunus mahaleb	Perfumed cherry	4	0.020	0.340	-0.054
Centaurea jacea	Brown knapweed	4	0.173	0.391	-0.058
Valeriana officinalis	Garden heliotrope	4	0.214	0.738	-0.060
Festuca pratensis	Meadow fescue	4	0.184	0.395	-0.061
Bromus squarrosus	Corn brome	4	0.041	0.347	-0.061
Digitalis lanata	Grecian foxglove	4	0.041	0.347	-0.061
Cirsium arvense	Canada thistle	4	0.724	0.818	-0.063
Artemisia absinthium	Common wormwood	4	0.408	0.469	-0.065
Froelichia gracilis	Cottonweed	4	0.051	0.350	-0.065
Lunaria annua	Money plant	4	0.051	0.350	-0.065
Phalaris canariensis	Canary grass	4	0.061	0.354	-0.068
Robinia hispida	Rose-acacia	4	0.061	0.354	-0.068
Verbascum blattaria	Moth muellin	4	0.204	0.401	-0.068
Cytisus scoparius	Scotch Broom	4	0.010	0.309	-0.071
Setaria faberi	Giant foxtail	4	0.071	0.357	-0.071
Digitalis purpurea	Foxglove	4	0.082	0.361	-0.075
Campanula rapunculoides	Creeping bellflower	4	0.418	0.667	-0.078
Bromus japonicus	Japanese brome	4	0.092	0.364	-0.078
Datura stramonium	Jimsonweed	4	0.102	0.367	-0.082
Panicum miliaceum	Broomcorn millet	4	0.118	0.373	-0.087

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Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Echium vulgare	Viper's bugloss	4	0.276	0.425	-0.092
Bromus inermis	Smooth brome	4	0.694	0.815	-0.093
Galinsoga quadriradiata	Quickweed	4	0.286	0.429	-0.095
Cichorium intybus	Chicory	4	0.469	0.640	-0.097
Fumaria officinalis	Fumitory	4	0.010	0.337	-0.099
Lychnis flos-cuculi	Ragged robin	4	0.010	0.337	-0.099
Cynoglossum officinale	Hound's tongue	4	0.408	0.636	-0.100
Sonchus oleraceus	Common sow thistle	4	0.173	0.724	-0.105
Festuca elatior	Tall fescue	4	0.255	0.668	-0.109
Allium vineale	Wild garlic	4	0.041	0.347	-0.109
Gypsophila paniculata	Baby's breath	4	0.184	0.395	-0.109
Crepis tectorum	Hawksbeard	4	0.398	0.688	-0.111
Centaurium pulchellum	Branching centaury	4	0.051	0.350	-0.112
Odontites serotina	Eyebright	4	0.051	0.350	-0.112
Tanacetum vulgare	Tansy	4	0.673	0.756	-0.116
Hieracium aurantiacum	Orange hawkweed	4	0.878	0.876	-0.117
Asparagus officinalis	Asparagus	4	0.480	0.618	-0.118
Phlox paniculata	Garden phlox	4	0.224	0.408	-0.122
Leonurus cardiaca	Motherwort	4	0.439	0.667	-0.124
Glaucium flavum	Horned poppy	4	0.010	0.337	-0.146
Tragopogon pratensis	Yellow goat's beard	4	0.449	0.677	-0.147
Trifolium repens	White clover	4	0.796	0.789	-0.148
Bromus tectorum	Downy chess	4	0.306	0.435	-0.150
Hypericum perforatum	St. John's wort	4	0.724	0.753	-0.158
Taraxacum officinale	Common dandelion	4	0.786	0.804	-0.165
Dactylis glomerata	Orchard-grass	4	0.439	0.702	-0.165
Poa compressa	Canada bluegrass	4	0.706	0.798	-0.173
Convolvulus arvensis	Field bindweed	4	0.347	0.682	-0.182
Stellaria media	Common chickweed	4	0.418	0.473	-0.187

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Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Elytrigia repens	Quackgrass	4	0.755	0.823	-0.197
Melilotus officinalis	Yellow sweet clover	4	0.704	0.843	-0.201
Thlaspi arvense	Field pennycress	4	0.378	0.654	-0.201
Potentilla recta	Sulphur cinquefoil	4	0.827	0.692	-0.202
Rumex acetosella	Sheep sorrell	4	0.908	0.830	-0.204
Phleum pratense	Timothy	4	0.806	0.727	-0.204
Stellaria graminea	Common stitchwort	4	0.378	0.793	-0.209
Trifolium pratense	Red clover	4	0.857	0.786	-0.210
Malva neglecta	Common mallow	4	0.469	0.601	-0.214
Saponaria officinalis	Soapwort	4	0.684	0.867	-0.224
Amaranthus retroflexus	Redroot pigweed	4	0.449	0.700	-0.226
Chrysanthemum leucanthemum	Ox-eye daisy	4	0.857	0.780	-0.231
Melilotus alba	White sweet clover	4	0.796	0.883	-0.233
Sedum acre	Yellow sedum	4	0.316	0.772	-0.248
Verbascum thapsus	Giant muellin	4	0.878	0.786	-0.264
Galeopsis tetrahit	Hemp nettle	4	0.622	0.791	-0.273
Matricaria matricarioides	Pineapple weed	4	0.745	0.707	-0.290
Lolium perenne	Rye grass	4	0.265	0.755	-0.295
Berteroa incana	Hoary alyssum	4	0.806	0.831	-0.305
Amaranthus hybridus	Green amaranthus	4	0.031	0.677	-0.308
Senecio vulgaris	Common groundsel	4	0.245	0.748	-0.308
Potentilla argentea	Silvery cinquefoil	4	0.888	0.824	-0.316
Lapsana communis	Nipplewort	4	0.163	0.721	-0.316
Malva moschata	Musk mallow	4	0.398	0.799	-0.323
Vicia villosa	Hairy vetch	4	0.776	0.842	-0.324
Cerastium vulgatum	Mouse-ear chickweed	4	0.867	0.856	-0.372
Silene vulgaris	Bladder campion	4	0.612	0.801	-0.385
Silene latifolia	White campion	4	0.929	0.810	-0.480
Dianthus armeria	Deptford pink	4	0.439	0.813	-0.495

APPENDIX C

Management category, relative abundance, feasibility of control, and management priority for dry, open habitats.

APPENDIX D

Management category, relative abundance, feasibility of control, and management priority for dry, shaded habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Pachysandra terminalis	Pachysandra	1	0.000	0.333	1.095
Viburnum plicatum	Japanese snowball	1	0.000	0.333	1.095
Actinidia arguta	Bower actinidia	1	0.000	0.333	1.048
Aralia elata	Japanese angelica tree	1	0.000	0.333	1.048
Arctium vulgare	Woodland burdock	1	0.000	0.333	1.048
Euonymus alatus	Winged euonymus	1	0.000	0.333	1.048
Polygonum aubertii	Silver lace vine	1	0.000	0.333	1.048
Rhamnus citrifolia	Dahurian buckthorn	1	0.000	0.333	1.048
Rhodotypos scandens	Black jetbead	1	0.000	0.333	1.048
Taxus cuspidata	Japanese yew	1	0.000	0.333	1.048
Vincetoxicum nigrum	Black swallow wort	1	0.000	0.333	1.048
Akebia quinata	Five-leaf akebia	1	0.000	0.333	1.048
Hedera helix	English ivy	1	0.000	0.333	1.048
Ilex crenata	Japanese holly	1	0.000	0.333	1.048
Rubus phoenicolasius	Wineberry	1	0.000	0.333	1.048
Tussilago farfara	Coltsfoot	1	0.000	0.333	1.048
Wisteria floribunda	Japanese wisteria	1	0.000	0.333	1.048
Brachypodium sylvaticum	Slender false brome	1	0.000	0.333	1.000
Ampelopsis brevipedunculata	Porcelain berry	1	0.000	0.333	1.000
Leucojum aestivum	Summer snowflake	1	0.000	0.333	1.000
Quercus robur	English oak	1	0.000	0.333	1.000
Viburnum dilatatum	Linden arrowwood	1	0.000	0.333	1.000
Viburnum sieboldii	Japanese viburnum	1	0.000	0.333	1.000
Geranium nepalense	Sweet Nepalese crane's bill	1	0.000	0.333	1.000
Acer palmatum	Japanese maple	1	0.000	0.333	0.952
Vincetoxicum rossicum	Swallow wort	1	0.000	0.333	0.952
Humulus japonicus	Japanese hops	1	0.000	0.333	0.952
Perilla frutescens	Perilla	1	0.000	0.333	0.952
Celastrus orbiculatus	Oriental bittersweet	1	0.000	0.625	0.946

APPENDIX D

Management category, relative abundance, feasibility of control, and management priority for dry, shaded habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Cardamine impatiens	Bushy rock cress	1	0.000	0.333	0.905
Polygonum cespitosum	Smartweed	1	0.000	0.583	0.905
Lonicera japonica	Japanese honeysuckle	2	0.010	0.545	0.300
Polygonum sachalinense	Giant knotweed	2	0.051	0.350	0.221
Rhamnus cathartica	Common buckthorn	2	0.204	0.651	0.205
Convallaria majalis	European lily of the valley	2	0.143	0.492	0.169
Epipactis helleborine	Helleborine	2	0.071	0.579	0.165
Vinca minor	Greater periwinkle	2	0.214	0.655	0.147
Lonicera maackii	Amur honeysuckle	2	0.031	0.594	0.145
Knautia arvensis	Field scabious	2	0.102	0.367	0.133
Berberis thunbergii	Japanese barberry	2	0.214	0.583	0.132
Linaria dalmatica	Dalmatian toadflax	2	0.194	0.259	0.122
Galium mollugo	Wild madder	2	0.112	0.496	0.111
Lonicera spp.	European bush honeysuckles	2	0.551	0.701	0.104
Euonymus europaeus	Spindle tree	2	0.010	0.337	0.092
Hieracium x atramentarium	Hawkweed	2	0.010	0.337	0.092
Geranium pratense	Wild geranium	2	0.020	0.340	0.088
Sedum kamtschaticum	Kamtschatica stonecrop	2	0.020	0.340	0.088
Myosotis sylvatica	Garden forget-me-not	2	0.337	0.571	0.080
Lupinus polyphyllus	Bigleaf lupine	2	0.143	0.575	0.073
Hesperis matronalis	Dame's rocket	2	0.337	0.696	0.065
Anthoxanthum odoratum	Sweet vernal grass	2	0.133	0.544	0.057
Caragana arborescens	Siberian pea shrub	2	0.092	0.531	0.053
Clematis terniflora	Yam-leaved clematis	2	0.010	0.337	0.044
Euonymus fortunei	Climbing euonymus	2	0.010	0.337	0.044
Wisteria sinensis	Chinese wisteria	2	0.010	0.337	0.044
Ligustrum obtusifolium	Amur river privet	3	0.020	0.340	0.041
Aruncus dioicus	Goat's beard	3	0.031	0.344	0.037
Lonicera xylosteum	European fly honeysuckle	3	0.031	0.344	0.037

APPENDIX D

Management category, relative abundance, feasibility of control, and management priority for dry, shaded habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Acer platanoides	Norway maple	3	0.061	0.479	0.033
Viburnum lantana	Wayfaring tree	3	0.051	0.350	0.031
Ajuga reptans	Carpet bugle	3	0.092	0.614	0.029
Sorbus aucuparia	Eurasian mountain ash	3	0.061	0.354	0.027
Hemerocallis fulva	Orange daylily	3	0.296	0.724	0.026
Humulus lupulus var. lupulus	Hops	3	0.067	0.356	0.025
Galium verum	Yellow bedstraw	3	0.122	0.374	0.007
Ribes sativum	Garden red currant	3	0.122	0.374	0.007
Polygonum cuspidatum	Japanese knotweed	3	0.204	0.672	0.004
Acer pseudoplatanus	Sycamore maple	3	0.010	0.337	-0.003
Acer ginnala	Amur maple	3	0.031	0.344	-0.010
Anthriscus sylvestris	Wild chervil	3	0.031	0.344	-0.010
Lathyrus sylvestris	Everlasting pea	3	0.173	0.391	-0.010
Lamium maculatum	Red dead nettle	3	0.041	0.347	-0.014
Ailanthus altissima	Tree of heaven	3	0.071	0.357	-0.024
Symphytum officinale	Comfrey	3	0.214	0.405	-0.024
Berberis vulgaris	Common barberry	4	0.102	0.367	-0.034
Torilis japonica	Japanese hedge-parsley	4	0.031	0.677	-0.034
Arctium minus	Common burdock	4	0.633	0.700	-0.043
Veronica officinalis	Speedwell	4	0.367	0.678	-0.054
Valeriana officinalis	Garden heliotrope	4	0.214	0.738	-0.060
Festuca pratensis	Meadow fescue	4	0.184	0.395	-0.061
Cirsium arvense	Canada thistle	4	0.724	0.818	-0.063
Chelidonium majus	Greater celandine	4	0.051	0.350	-0.065
Digitalis purpurea	Foxglove	4	0.082	0.361	-0.075
Campanula rapunculoides	Creeping bellflower	4	0.418	0.667	-0.078
Cynoglossum officinale	Hound's tongue	4	0.408	0.636	-0.100
Glechoma hederacea	Gill over the ground	4	0.480	0.795	-0.106
Festuca elatior	Tall fescue	4	0.255	0.668	-0.109

APPENDIX D

Management category, relative abundance, feasibility of control, and management priority for dry, shaded habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Hieracium aurantiacum	Orange hawkweed	4	0.878	0.876	-0.117
Phlox paniculata	Garden phlox	4	0.224	0.408	-0.122
Leonurus cardiaca	Motherwort	4	0.439	0.667	-0.124
Hypericum perforatum	St. John's wort	4	0.724	0.753	-0.158
Taraxacum officinale	Common dandelion	4	0.786	0.804	-0.165
Dactylis glomerata	Orchard-grass	4	0.439	0.702	-0.165
Stellaria media	Common chickweed	4	0.418	0.473	-0.187
Potentilla recta	Sulphur cinquefoil	4	0.827	0.692	-0.202
Chrysanthemum leucanthemum	Ox-eye daisy	4	0.857	0.780	-0.231
Galeopsis tetrahit	Hemp nettle	4	0.622	0.791	-0.273
Lapsana communis	Nipplewort	4	0.163	0.721	-0.316

APPENDIX E

Management category, relative abundance, feasibility of control, and management priority for moist, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Ampelamus albidus	Sandvine	1	0.000	0.333	1.095
Alnus glutinosa	Black alder	1	0.000	0.333	1.048
Urtica dioica var. dioica	Stinging nettle	1	0.000	0.333	1.048
Heracleum mantegazzianum	Giant hogweed	1	0.000	0.333	1.000
Setaria glauca	Yellow foxtail	1	0.000	0.472	0.997
Poa bulbosa	Bulbous bluegrass	1	0.000	0.333	0.952
Polygonum perfoliatum	Mile-a-minute vine	1	0.000	0.333	0.905
Lysimachia vulgaris	Garden loosestrife	2	0.031	0.469	0.246
Calamagrostis epigejos	Feathertop	2	0.020	0.340	0.088
Ranunculus repens	Creeping buttercup	3	0.162	0.387	0.041
Lotus corniculatus	Bird's-foot trefoil	3	0.398	0.633	0.025
Prunella vulgaris var. vulgaris	Heal-all	3	0.200	0.633	0.012
Achillea ptarmica	Sneezeweed	3	0.133	0.378	0.003
Salix spp.	Crack & white willows	3	0.286	0.540	-0.028
Morus alba	White mulberry	4	0.112	0.371	-0.037
Ornithogalum umbellatum	Star of Bethlehem	4	0.010	0.337	-0.051
Valeriana officinalis	Garden heliotrope	4	0.214	0.738	-0.060
Lactuca serriola	Prickly lettuce	4	0.316	0.522	-0.062
Setaria faberi	Giant foxtail	4	0.071	0.357	-0.071
Cannabis sativa	Hemp	4	0.143	0.381	-0.095
Festuca elatior	Tall fescue	4	0.255	0.668	-0.109
Solanum dulcamara	Climbing nightshade	4	0.571	0.774	-0.119
Ranunculus acris var. acris	Tall buttercup	4	0.724	0.700	-0.120
Poa annua	Annual bluegrass	4	0.324	0.608	-0.132
Arenaria serpyllifolia	Thyme-leaf sandwort	4	0.357	0.452	-0.143
Trifolium repens	White clover	4	0.796	0.789	-0.148
Sonchus asper	Prickly sow thistle	4	0.388	0.713	-0.149
Plantago lanceolata	Plantain	4	0.663	0.763	-0.152
Poa compressa	Canada bluegrass	4	0.706	0.798	-0.173

APPENDIX E

Management category, relative abundance, feasibility of control, and management priority for moist, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Sonchus arvensis	Field sow thistle	4	0.796	0.890	-0.174
Poa pratensis	Kentucky bluegrass	4	0.813	0.863	-0.191
Medicago lupulina	Black medic	4	0.622	0.728	-0.204
Trifolium pratense	Red clover	4	0.857	0.786	-0.210
Rumex crispus	Curly dock	4	0.684	0.783	-0.219
Amaranthus retroflexus	Redroot pigweed	4	0.449	0.700	-0.226
Nepeta cataria	Catnip	4	0.582	0.694	-0.241
Plantago major	Plantain	4	0.816	0.786	-0.270
Stellaria aquatica	Giant chickweed	4	0.276	0.759	-0.282
Capsella bursa-pastoris	Shepard's purse	4	0.776	0.742	-0.297

APPENDIX F

Management category, relative abundance, feasibility of control, and management priority for moist, shaded habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Ampelamus albidus	Sandvine	1	0.000	0.333	1.095
Alnus glutinosa	Black alder	1	0.000	0.333	1.048
Urtica dioica var. dioica	Stinging nettle	1	0.000	0.333	1.048
Aralia spinosa	Hercules' club	1	0.000	0.333	1.000
Lamium galeobdolon	Yellow dead nettle	1	0.000	0.333	1.000
Ranunculus ficaria	Lesser celandine	1	0.000	0.333	1.000
Microstegium vimineum	Japanese stilt grass	1	0.000	0.333	0.952
Polygonum perfoliatum	Mile-a-minute vine	1	0.000	0.333	0.905
Lysimachia vulgaris	Garden loosestrife	2	0.031	0.469	0.246
Alliaria petiolata	Garlic mustard	2	0.092	0.614	0.203
Rhamnus frangula	Glossy buckthorn	2	0.265	0.665	0.177
Calamagrostis epigejos	Feathertop	2	0.020	0.340	0.088
Viburnum opulus var. opulus	European cranberry bush	2	0.067	0.606	0.049
Ranunculus repens	Creeping buttercup	3	0.162	0.387	0.041
Ligustrum vulgare	European privet	3	0.031	0.344	0.037
Prunella vulgaris var. vulgaris	Heal-all	3	0.200	0.633	0.012
Achillea ptarmica	Sneezeweed	3	0.133	0.378	0.003
Aegopodium podagraria	Goutweed	4	0.092	0.364	-0.031
Morus alba	White mulberry	4	0.112	0.371	-0.037
Ornithogalum umbellatum	Star of Bethlehem	4	0.010	0.337	-0.051
Valeriana officinalis	Garden heliotrope	4	0.214	0.738	-0.060
Commelina communis	Dayflower	4	0.071	0.357	-0.071
Festuca elatior	Tall fescue	4	0.255	0.668	-0.109
Solanum dulcamara	Climbing nightshade	4	0.571	0.774	-0.119
Ranunculus acris var. acris	Tall buttercup	4	0.724	0.700	-0.120
Poa pratensis	Kentucky bluegrass	4	0.813	0.863	-0.191

APPENDIX G

Management category, relative abundance, feasibility of control, and management priority for wet, open habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Alnus glutinosa	Black alder	1	0.000	0.333	1.048
Angelica sylvestris	Woodland angelica	1	0.000	0.333	1.048
Deschampsia cespitosa var. parviflora	Small-flowered tickle-grass	1	0.000	0.333	1.048
Rorippa amphibia	Great water cress	1	0.000	0.333	1.048
Sonchus palustris	Marsh sow thistle	1	0.000	0.333	1.048
Betula pendula	Weeping birch	1	0.000	0.333	1.000
Bidens aristosa	Beggar ticks	1	0.000	0.333	1.000
Arthraxon hispidus	Small carpgrass	1	0.000	0.333	0.952
Lysimachia vulgaris	Garden loosestrife	2	0.031	0.469	0.246
Filipendula ulmaria	Queen of the meadow	2	0.031	0.427	0.192
Cirsium palustre	Marsh thistle	2	0.276	0.675	0.151
Lysimachia nummularia	Moneywort	2	0.122	0.707	0.114
Mentha aquatica	Water mint	2	0.020	0.340	0.088
Epilobium hirsutum	Hairy willow herb	3	0.082	0.361	0.020
Conium maculatum	Poison hemlock	3	0.102	0.340	-0.006
Impatiens glandulifera	Purple jewelweed	3	0.020	0.340	-0.007
Poa trivialis	Rough bluegrass	3	0.044	0.348	-0.015
Phalaris arundinacea	Reed canary grass	3	0.957	0.944	-0.022
Salix spp.	Crack & white willows	3	0.286	0.540	-0.028
Mentha x gentilis	Scotch mint	4	0.112	0.371	-0.037
Mentha spicata	Spearmint	4	0.122	0.374	-0.041
Rumex obtusifolius	Bitter dock	4	0.541	0.514	-0.049
Agrostis stolonifera	Creeping bent	4	0.296	0.626	-0.049
Ranunculus acris var. acris	Tall buttercup	4	0.724	0.700	-0.120
Echinochloa crusgalli	Barnyard grass	4	0.398	0.563	-0.131
Salix babylonica	Weeping willow	4	0.041	0.555	-0.139

APPENDIX H

Management category, relative abundance, feasibility of control, and management priority for wet, shaded habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Alnus glutinosa	Black alder	1	0.000	0.333	1.048
Angelica sylvestris	Woodland angelica	1	0.000	0.333	1.048
Deschampsia cespitosa var. parviflora	Small-flowered tickle-grass	1	0.000	0.333	1.048
Aralia spinosa	Hercules' club	1	0.000	0.333	1.000
Bidens aristosa	Beggar ticks	1	0.000	0.333	1.000
Ranunculus ficaria	Lesser celandine	1	0.000	0.333	1.000
Lysimachia vulgaris	Garden loosestrife	2	0.031	0.469	0.246
Filipendula ulmaria	Queen of the meadow	2	0.031	0.427	0.192
Cirsium palustre	Marsh thistle	2	0.276	0.675	0.151
Lysimachia nummularia	Moneywort	2	0.122	0.707	0.114
Mentha aquatica	Water mint	2	0.020	0.340	0.088
Epilobium hirsutum	Hairy willow herb	3	0.082	0.361	0.020
Conium maculatum	Poison hemlock	3	0.102	0.340	-0.006
Impatiens glandulifera	Purple jewelweed	3	0.020	0.340	-0.007
Poa trivialis	Rough bluegrass	3	0.044	0.348	-0.015
Phalaris arundinacea	Reed canary grass	3	0.957	0.944	-0.022
Mentha x gentilis	Scotch mint	4	0.112	0.371	-0.037
Mentha spicata	Spearmint	4	0.122	0.374	-0.041
Rumex obtusifolius	Bitter dock	4	0.541	0.514	-0.049
Agrostis stolonifera	Creeping bent	4	0.296	0.626	-0.049
Ranunculus acris var. acris	Tall buttercup	4	0.724	0.700	-0.120

APPENDIX I

Management category, relative abundance, feasibility of control, and management priority for aquatic habitats.

Latin Name	Common Name	Management Category	Relative Abundance	Feasibility of Control	Management Priority
Hydrilla verticillata	Hydrilla	1	0.000	0.278	1.103
Cabomba caroliniana	Fanwort	1	0.000	0.333	1.095
Marsilea quadrifolia	Water clover	1	0.000	0.333	1.095
Najas minor	Naiad	1	0.000	0.333	1.095
Rorippa microphylla	Watercress	1	0.000	0.625	1.089
Ludwigia peploides	Creeping primrose	1	0.000	0.306	1.075
Cardamine pratensis var. pratensis	Cuckoo flower	1	0.000	0.333	1.048
Hydrocharis morsus-ranae	European frogbit	1	0.000	0.333	1.048
Crassula helmsii	Australian stonecrop	1	0.000	0.333	1.048
Glyceria maxima	Tall mannagrass	1	0.000	0.333	1.048
Salvinia molesta	Kariba weed	1	0.000	0.306	1.028
Egeria densa	Brazilian water weed	1	0.000	0.333	1.000
Trapa natans	Water chestnut	1	0.000	0.333	1.000
Nymphoides peltata	Yellow floating heart	1	0.000	0.333	0.952
Lythrum salicaria	Purple loosestrife	2	0.429	0.605	0.266
Butomus umbellatus	Flowering rush	2	0.041	0.430	0.260
Typha x glauca	Hybrid cattail	2	0.261	0.698	0.183
Myriophyllum spicatum	Eurasian water milfoil	2	0.173	0.646	0.179
Typha angustifolia	Narrow-leaved cattail	2	0.327	0.642	0.136
Iris pseudacorus	Yellow Iris	2	0.092	0.614	0.084
Potamogeton crispus	Curly pondweed	2	0.347	0.741	0.050
Mentha x piperita	Peppermint	3	0.245	0.415	0.014
Callitriche stagnalis	European water starwort	3	0.010	0.337	-0.003
Myosotis scorpioides	Forget-me-not	4	0.510	0.781	-0.111
Rorippa nasturtium-aquaticum	Watercress	4	0.378	0.793	-0.146

APPENDIX J

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Management Category	Regional Management Category
Acer palmatum	Japanese maple	1	1
Actinidia arguta	Bower actinidia	1	1
Aira caryophyllea	Silver hairgrass	1	1
Akebia quinata	Five-leaf akebia	1	1
Alnus glutinosa	Black alder	1	1
Ampelamus albidus	Sandvine	1	1
Ampelopsis brevipedunculata	Porcelain berry	1	1
Angelica sylvestris	Woodland angelica	1	1
Aralia elata	Japanese angelica tree	1	1
Aralia spinosa	Hercules' club	1	1
Arctium vulgare	Woodland burdock	1	1
Arthraxon hispidus	Small carpgrass	1	1
Bidens aristosa	Beggar ticks	1	1
Bothriochloa bladhii	Eurasian bluestem	1	1
Brachypodium sylvaticum	Slender false brome	1	1
Cabomba caroliniana	Fanwort	1	1
Cardamine impatiens	Bushy rock cress	1	1
Cardamine pratensis var. pratensis	Cuckoo flower	1	1
Carex kobomugi	Asiatic sedge	1	1
Celastrus orbiculatus	Oriental bittersweet	1	1
Centaurea repens	Russian knapweed	1	1
Chloris verticillata	Windmill grass	1	1
Crassula helmsii	Australian stonecrop	1	1
Deschampsia cespitosa var. parviflora	Small-flowered tickle-grass	1	1
Dioscorea batatas	Cinnamon vine	1	1
Dipsacus fullonium	Fuller's teasel	1	1
Egeria densa	Brazilian water weed	1	1
Elsholtzia ciliata	Elsholtzia	1	1
Euonymus alatus	Winged euonymus	1	1
Geranium nepalense	Sweet Nepalese crane's bill	1	1

APPENDIX J

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Management Category	Regional Management Category
Glyceria maxima	Tall mannagrass	1	1
Hedera helix	English ivy	1	1
Heracleum mantegazzianum	Giant hogweed	1	1
Humulus japonicus	Japanese hops	1	1
Hydrilla verticillata	Hydrilla	1	1
Hydrocharis morsus-ranae	European frogbit	1	1
Ilex crenata	Japanese holly	1	1
Lamium galeobdolon	Yellow dead nettle	1	1
Lepidium latifolium	Tall pepperwort	1	1
Lespedeza stipulacea	Korean clover	1	1
Lespedeza striata	Bush clover	1	1
Leucojum aestivum	Summer snowflake	1	1
Ludwigia peploides	Creeping primrose	1	1
Marsilea quadrifolia	Water clover	1	1
Microstegium vimineum	Japanese stilt grass	1	1
Miscanthus sinensis	Eulalia	1	1
Najas minor	Naiad	1	1
Pachysandra terminalis	Pachysandra	1	1
Panicum amarum	Beach grass	1	1
Perilla frutescens	Perilla	1	1
Phellodendron amurense	Amur cork tree	1	1
Phellodendron japonicum	Japanese cork tree	1	1
Picris hieracioides ssp. hieracioides	Oxtongue	1	1
Pinus virginiana	Virginia pine	1	1
Poa bulbosa	Bulbous bluegrass	1	1
Polygonum aubertii	Silver lace vine	1	1
Polygonum cespitosum	Smartweed	1	1
Polygonum perfoliatum	Mile-a-minute vine	1	1
Quercus robur	English oak	1	1
Ranunculus ficaria	Lesser celandine	1	1

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Mana
Rhamnus citrifolia	Dahurian buckthorn	
Rhodotypos scandens	Black jetbead	
Rorippa amphibia	Great water cress	
Rorippa microphylla	Watercress	
Rubus phoenicolasius	Wineberry	
Sonchus palustris	Marsh sow thistle	
Sorghum halepense	Johnson grass	
Spiraea prunifolia	Bridalwreath spirea	
Stratiotes aloides	Water aloe	
Taxus cuspidata	Japanese yew	
Torilis arvensis	Field hedge-parsley	
Trapa natans	Water chestnut	
Tussilago farfara	Coltsfoot	
Ulmus parvifolia	Chinese elm	
Urtica dioica var. dioica	Stinging nettle	
Viburnum dilatatum	Linden arrowwood	
Viburnum plicatum	Japanese snowball	
Viburnum sieboldii	Japanese viburnum	
Vincetoxicum nigrum	Black swallow wort	
Vincetoxicum rossicum	Swallow wort	
Wisteria floribunda	Japanese wisteria	
Alliaria petiolata	Garlic mustard	
Butomus umbellatus	Flowering rush	
Carduus acanthoides	Plumeless thistle	
Carduus nutans	Musk thistle	
Centaurea diffusa	Diffuse knapweed	
Centaurea solstitialis	Yellow starthistle	
Cirsium palustre	Marsh thistle	
Clematis terniflora	Yam-leaved clematis	
Epipactis helleborine	Helleborine	

APPENDIX J

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Management Category	Regional Management Category
Rhamnus citrifolia	Dahurian buckthorn	1	1
Rhodotypos scandens	Black jetbead	1	1
Rorippa amphibia	Great water cress	1	1
Rorippa microphylla	Watercress	1	1
Rubus phoenicolasius	Wineberry	1	1
Sonchus palustris	Marsh sow thistle	1	1
Sorghum halepense	Johnson grass	1	1
Spiraea prunifolia	Bridalwreath spirea	1	1
Stratiotes aloides	Water aloe	1	1
Taxus cuspidata	Japanese yew	1	1
Torilis arvensis	Field hedge-parsley	1	1
Trapa natans	Water chestnut	1	1
Tussilago farfara	Coltsfoot	1	1
Ulmus parvifolia	Chinese elm	1	1
Urtica dioica var. dioica	Stinging nettle	1	1
Viburnum dilatatum	Linden arrowwood	1	1
Viburnum plicatum	Japanese snowball	1	1
Viburnum sieboldii	Japanese viburnum	1	1
Vincetoxicum nigrum	Black swallow wort	1	1
Vincetoxicum rossicum	Swallow wort	1	1
Wisteria floribunda	Japanese wisteria	1	1
Alliaria petiolata	Garlic mustard	1	2
Butomus umbellatus	Flowering rush	1	2
Carduus acanthoides	Plumeless thistle	1	2
Carduus nutans	Musk thistle	1	2
Centaurea diffusa	Diffuse knapweed	1	2
Centaurea solstitialis	Yellow starthistle	1	2
Cirsium palustre	Marsh thistle	1	2
Clematis terniflora	Yam-leaved clematis	1	2
Epipactis helleborine	Helleborine	1	2

APPENDIX J

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Management Category	Regional Management Category
Euonymus europaeus	Spindle tree	1	2
Euonymus fortunei	Climbing euonymus	1	2
Galium mollugo	Wild madder	1	2
Geranium pratense	Wild geranium	1	2
Hesperis matronalis	Dame's rocket	1	2
Hieracium lachenalii	Hawkweed	1	2
Hieracium x atramentarium	Hawkweed	1	2
Lonicera japonica	Japanese honeysuckle	1	2
Lonicera maackii	Amur honeysuckle	1	2
Lysimachia nummularia	Moneywort	1	2
Lysimachia vulgaris	Garden loosestrife	1	2
Lythrum salicaria	Purple loosestrife	1	2
Maclura pomifera	Osage orange	1	2
Mentha aquatica	Water mint	1	2
Myriophyllum spicatum	Eurasian water milfoil	1	2
Potamogeton crispus	Curly pondweed	1	2
Rosa multiflora	Multiflora rose	1	2
Rosa rugosa	Beach rose	1	2
Sedum kamtschaticum	Kamtschatica stonecrop	1	2
Senecio jacobaea	Tansy ragwort	1	2
Viburnum opulus var. opulus	European cranberry bush	1	2
Wisteria sinensis	Chinese wisteria	1	2
Acer ginnala	Amur maple	1	3
Acer pseudoplatanus	Sycamore maple	1	3
Ailanthus altissima	Tree of heaven	1	3
Ajuga reptans	Carpet bugle	1	3
Anthriscus sylvestris	Wild chervil	1	3
Arrhenatherum elatius	Tall oatgrass	1	3
Aruncus dioicus	Goat's beard	1	3
Callitriche stagnalis	European water starwort	1	3

APPENDIX J

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Management Category	Regional Management Category
Centaurea dubia	Short-fringed knapweed	1	3
Centaurea nigra	Black knapweed	1	3
Conium maculatum	Poison hemlock	1	3
Dipsacus laciniatus	Cut-leaved teasel	1	3
Epilobium hirsutum	Hairy willow herb	1	3
Hemerocallis fulva	Orange daylily	1	3
Humulus lupulus var. lupulus	Hops	1	3
Impatiens glandulifera	Purple jewelweed	1	3
Kochia scoparia	Summer cypress	1	3
Lamium maculatum	Red dead nettle	1	3
Leontodon autumnalis	Fall dandelion	1	3
Lespedeza cuneata	Chinese lespedeza	1	3
Ligustrum obtusifolium	Amur river privet	1	3
Ligustrum vulgare	European privet	1	3
Lonicera xylosteum	European fly honeysuckle	1	3
Mentha x piperita	Peppermint	1	3
Onopordum acanthium	Scotch thistle	1	3
Poa trivialis	Rough bluegrass	1	3
Polygonum cuspidatum	Japanese knotweed	1	3
Populus alba	White poplar	1	3
Prunus avium	Sweet cherry	1	3
Ribes sativum	Garden red currant	1	3
Sedum purpureum	Live forever	1	3
Spiraea japonica	Japanese spiraea	1	3
Symphytum officinale	Comfrey	1	3
Thymus serpyllum	Thyme	1	3
Allium vineale	Wild garlic	1	4
Amaranthus hybridus	Green amaranthus	1	4
Arenaria serpyllifolia	Thyme-leaf sandwort	1	4
Artemisia absinthium	Common wormwood	1	4

APPENDIX J

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Management Category	Regional Management Category
Asparagus officinalis	Asparagus	1	4
Berberis vulgaris	Common barberry	1	4
Berteroa incana	Hoary alyssum	1	4
Bromus japonicus	Japanese brome	1	4
Bromus squarrosus	Corn brome	1	4
Bromus tectorum	Downy chess	1	4
Cannabis sativa	Hemp	1	4
Centaurea cyanus	Bachelor's buttons	1	4
Centaurea jacea	Brown knapweed	1	4
Centaurea x pratensis	Meadow knapweed	1	4
Centaurium pulchellum	Branching centaury	1	4
Chelidonium majus	Greater celandine	1	4
Commelina communis	Dayflower	1	4
Cynoglossum officinale	Hound's tongue	1	4
Cytisus scoparius	Scotch Broom	1	4
Datura stramonium	Jimsonweed	1	4
Digitalis lanata	Grecian foxglove	1	4
Digitalis purpurea	Foxglove	1	4
Dipsacus sylvestris	Common teasel	1	4
Echium vulgare	Viper's bugloss	1	4
Froelichia gracilis	Cottonweed	1	4
Fumaria officinalis	Fumitory	1	4
Gypsophila paniculata	Baby's breath	1	4
Lactuca serriola	Prickly lettuce	1	4
Lunaria annua	Money plant	1	4
Medicago lupulina	Black medic	1	4
Mentha spicata	Spearmint	1	4
Morus alba	White mulberry	1	4
Nepeta cataria	Catnip	1	4
Odontites serotina	Eyebright	1	4

APPENDIX J

Summary of local watch species and corresponding regional management categories.

Latin Name	Common Name	Local Management Category	Regional Management Category
Ornithogalum umbellatum	Star of Bethlehem	1	4
Panicum miliaceum	Broomcorn millet	1	4
Phalaris canariensis	Canary grass	1	4
Potentilla recta	Sulphur cinquefoil	1	4
Sedum acre	Yellow sedum	1	4
Sonchus oleraceus	Common sow thistle	1	4
Stellaria aquatica	Giant chickweed	1	4
Thlaspi arvense	Field pennycress	1	4
Torilis japonica	Japanese hedge-parsley	1	4